Final

Total Maximum Daily Loads

for

Dissolved Oxygen & Nutrients in

34th Street Basin, Clam Bayou Drain, Clam Bayou (East Drainage, Clam Bayou Drain (Tidal)

WBIDs 1716A, 1716B, 1716C & 1716D

July 2013

United States Environmental Protection Agency

Region 4 serving the southeast

In compliance with the provisions of the Federal Clean Water Act, 33 U.S.C §1251 et. seq., as amended by the Water Quality Act of 1987, P.L. 400-4, the U.S. Environmental Protection Agency is hereby establishing the Total Maximum Daily Load (TMDL) for dissolved oxygen and nutrients in the Springs Coast Basin (WBIDs 1716A, 1716B, 1716C, 1716D). Subsequent actions must be consistent with this TMDL.

/s/ __7/7/2013

James D. Giattina, Director
Water Protection Division

Date

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SUMMARY SHEET for WBID 1716A

Total Maximum Daily Load (TMDL)

2006 303(d) Listed Waterbodies for TMDLs addressed in this report:

WBID	Segment Name	Class and Waterbody Type	Major River Basin	HUC	County	State
1716A	34th Street Basin	Class III Freshwater	Springs Coast	3100207	Pinellas	Florida

TMDL Endpoints/Targets:

Dissolved Oxygen & Nutrients

TMDL Technical Approach:

The TMDL allocations were determined by analyzing the effects of TN, TP, and BOD concentrations and loadings on DO concentrations in the waterbody. A watershed model and estuary model were used to predict delivery of pollutant loads to the waterbody and to evaluate the in-stream impacts of the pollutant loads.

TMDL Waste Load and Load Allocation

Constituent	Current Condition		TMDL Condition		Percent Reduction		
	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	WLA	LA	MS4
Total Nitrogen	--	2,894	--	508	--	82%	82%
Total Phosphorus	--	307	--	42	--	86%	86%
Biochemical Oxygen Demand	--	8,960	--	2,529	--	72%	72%

Endangered Species Present (Yes or Blank):

USEPA Lead TMDL (USEPA or Blank): USEPA

TMDL Considers Point Source, Non-point Source, or Both: Both

Major NPDES Discharges to surface waters addressed in USEPA TMDL:

Permit ID	Permittee(s)	County	Permit Type
FLS000005	Pinellas County, Florida Department of Transportation	Pinellas	Phase I MS4
FLS000007	City of St. Petersburg	Pinellas	Phase I MS4

SUMMARY SHEET for WBID 1716B

Total Maximum Daily Load (TMDL)

2006 303(d) Listed Waterbodies for TMDLs addressed in this report:

WBID	Segment Name	Class and Waterbody Type	Major River Basin	HUC	County	State
1716B	Clam Bayou Drain	Class III Freshwater	Springs Coast	3100207	Pinellas	Florida

TMDL Endpoints/Targets:

Dissolved Oxygen & Nutrients

TMDL Technical Approach:

The TMDL allocations were determined by analyzing the effects of TN, TP, and BOD concentrations and loadings on DO concentrations in the waterbody. A watershed model and estuary model were used to predict delivery of pollutant loads to the waterbody and to evaluate the in-stream impacts of the pollutant loads.

TMDL Waste Load and Load Allocation

Constituent	Current Condition		TMDL Condition		Percent Reduction		
	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	WLA	LA	MS4
Total Nitrogen	--	1,010	--	194	--	81%	81%
Total Phosphorus	--	103	--	16	--	85%	85%
Biochemical Oxygen Demand	--	3,121	--	1,008	--	68%	68%

Endangered Species Present (Yes or Blank):

USEPA Lead TMDL (USEPA or Blank): USEPA

TMDL Considers Point Source, Non-point Source, or Both: Non-point

Major NPDES Discharges to surface waters addressed in USEPA TMDL:

Permit ID	Permittee(s)	County	Permit Type
FLS000005	Pinellas County, Florida Department of Transportation	Pinellas	Phase I MS4
FLS000007	City of St. Petersburg	Pinellas	Phase I MS4

SUMMARY SHEET for WBID 1716C
Total Maximum Daily Load (TMDL)

2006 303(d) Listed Waterbodies for TMDLs addressed in this report:

WBID	Segment Name	Class and Waterbody Type	Major River Basin	HUC	County	State
1716C	Clam Bayou (E Drainage)	Class III Marine	Springs Coast	3100207	Pinellas	Florida

TMDL Endpoints/Targets:

Dissolved Oxygen & Nutrients

TMDL Technical Approach:

The TMDL allocations were determined by analyzing the effects of TN, TP, and BOD concentrations and loadings on DO concentrations in the waterbody. A watershed model and estuary model were used to predict delivery of pollutant loads to the waterbody and to evaluate the in-stream impacts of the pollutant loads.

TMDL Waste Load and Load Allocation

Constituent	Current Condition		TMDL Condition		Percent Reduction		
	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	WLA	LA	MS4
Total Nitrogen	--	1,112	--	272	--	76%	76%
Total Phosphorus	--	120	--	23	--	81%	81%
Biochemical Oxygen Demand	--	2,921	--	1,198	--	59%	59%

Endangered Species Present (Yes or Blank):

USEPA Lead TMDL (USEPA or Blank): USEPA

TMDL Considers Point Source, Non-point Source, or Both: Both

Major NPDES Discharges to surface waters addressed in USEPA TMDL:

Permit ID	Permittee(s)	County	Permit Type
FLS000005	Pinellas County, Florida Department of Transportation	Pinellas	Phase I MS4
FLS000007	City of St. Petersburg	Pinellas	Phase I MS4

SUMMARY SHEET for WBID 1716D

Total Maximum Daily Load (TMDL)

2006 303(d) Listed Waterbodies for TMDLs addressed in this report:

WBID	Segment Name	Class and Waterbody Type	Major River Basin	HUC	County	State
1716D	Clam Bayou Drain (Tidal)	Class III Marine	Springs Coast	3100207	Pinellas	Florida

TMDL Endpoints/Targets:

Dissolved Oxygen & Nutrients

TMDL Technical Approach:

The TMDL allocations were determined by analyzing the effects of TN, TP, and BOD concentrations and loadings on DO concentrations in the waterbody. A watershed model and estuary model were used to predict delivery of pollutant loads to the waterbody and to evaluate the in-stream impacts of the pollutant loads.

TMDL Waste Load and Load Allocation

Constituent	Current Condition		TMDL Condition		Percent Reduction		
	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	WLA	LA	MS4
Total Nitrogen	--	5,441	--	1,075	--	80%	80%
Total Phosphorus	--	570	--	89	--	84%	84%
Biochemical Oxygen Demand	--	16,244	--	5,227	--	68%	68%

Endangered Species Present (Yes or Blank):

USEPA Lead TMDL (USEPA or Blank): USEPA

TMDL Considers Point Source, Non-point Source, or Both: Both

Major NPDES Discharges to surface waters addressed in USEPA TMDL:

Permit ID	Permittee(s)	County	Permit Type
FLS000005	Pinellas County, Florida Department of Transportation	Pinellas	Phase I MS4
FLS000007	City of St. Petersburg	Pinellas	Phase I MS4

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA 1991).

The Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework FDEP uses for implementing TMDLs. The state's 52 basins are divided into five groups and water quality is assessed in each group on a rotating five-year cycle. FDEP also established five water management districts (WMD) responsible for managing ground and surface water supplies in the counties encompassing the districts.

For the purpose of planning and management, the WMD further divided the districts into planning units defined as either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics. These planning units contain smaller, hydrological based units called drainage basins, which are further divided by FDEP into "water segments". A water segment usually contains only one unique waterbody type (stream, lake, canal, etc.) and is about 5 square miles. Unique numbers or waterbody identification (WBIDs) numbers are assigned to each water segment. All of the WBIDs addressed in this report are located in the Springs Coast Basin and are part of the Anclote River/Coastal Pinellas County Planning Unit. The WBIDs are Group 5 waterbodies located in the Southwest Florida Water Management District (SWFWMD). This TMDL report addresses WBIDs 1716A, 1716B, 1716C, and 1716D, impaired for dissolved oxygen and nutrients.

2.0 PROBLEM DEFINITION

To determine the status of surface water quality in Florida, three categories of data – chemistry data, biological data, and fish consumption advisories – were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Surface Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (FAC). The IWR is FDEP's methodology for determining whether waters should be included on the state's planning list and verified list. Potential impairments are determined by assessing whether a waterbody meets the criteria for inclusion on the planning list. Once a waterbody is on the planning list, additional data and information will be collected and examined to determine if the water should be included on the verified list.

The TMDLs addressed in this document are being established pursuant to commitments made by the United States Environmental Protection Agency (USEPA) in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998). That Consent Decree established a schedule for TMDL development for waters listed on Florida's USEPA approved 1998 section 303(d) list. The 2006 section 303(d) list identified numerous WBIDs in the Springs Coast Basin as not meeting WQS. After assessing all readily available water quality data, USEPA is responsible for developing a TMDL for all WBIDs depicted in Figure 2.1. The parameters addressed for each WBID are listed on Table 2.1.

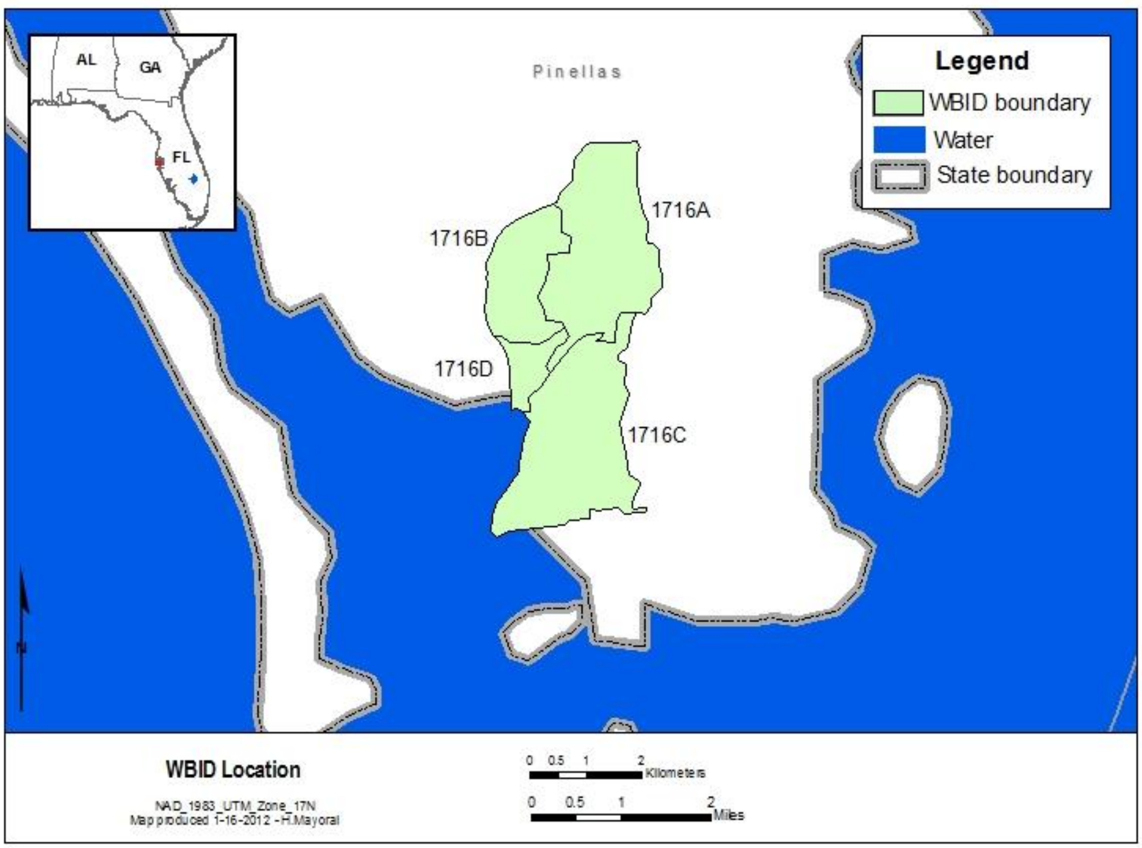

Figure 2.1 Location of impaired WBIDs in the Clam Bayou basin.

Table 2.1 Impaired WBIDs in the Clam Bayou basin.

WBID	Segment Name	Class	Parameters	Planning Unit
1716A	34th Street Basin	3F	DO & Nutrients	Anclote River/Coastal Pinellas County
1716B	Clam Bayou Drain	3F	DO & Nutrients	Anclote River/Coastal Pinellas County
1716C	Clam Bayou (E Drainage)	3M	DO & Nutrients	Anclote River/Coastal Pinellas County
1716D	Clam Bayou Drain (Tidal)	3M	DO & Nutrients	Anclote River/Coastal Pinellas County

3.0 WATERSHED DESCRIPTION

The Springs Coast Basin is located along the west coast, beginning just south of the Withlacoochee River in Citrus County and extends to Gulfport, Florida in Pinellas County, although it does not include Tampa Bay. Within the watershed lies six major rivers, Crystal River, Homosassa River, Chassahowitza River, Weeki Wachee, the Anclote River, and the Pithlachascotee River; along with numerous springs and lakes (FDEP). The Brooksville Ridge marks the eastern boundary, created by sands historically deposited during higher sea-levels, and which define the karst geology that is characteristic of the area (FDEP 2008).

Three physiographic regions with varying geology and topography are located within the Springs Coast Basin, the Coastal Swamps, the Gulf Coastal Lowlands, and the Brooksville Ridge. The Clam Bayou basin is located in the southwestern portion of the Springs Coast Basin in the Gulf Coastal Lowlands (SWFWMD 2001). The Gulf Coast Lowlands are characterized by flat river valleys and rolling hills formed by aeolian deposited sands. Much of the Gulf Costal Lowlands, including regions along the U.S. Highway 19 corridor, have been and continue to be intensively developed, although sections of federally owned tracts of wetlands and swamps have been preserved (FDEP). The southwest region of the Springs Coast has fewer springs than the northern region, and the springs have relatively low flow volumes (FDEP 2008).

3.1 Climate

The Springs Coast Basin is located in Central Florida and experiences a humid subtropical climate with distinct wet (May to October) and dry (November to April) seasons, high rates of evapotranspiration, and climatic extremes of floods, droughts, and hurricanes. Seasonal rainfall patterns resemble the wet and dry season patterns of humid tropics. Central Florida receives an average of 46 inches of rain every year, of which 75% falls during the wet season, which coincides with hurricane season (USACE and SFWMD 2010). Average temperatures during the wet season are in the low-80s (°F) and in the dry season are in the mid-60s (°F) (NOAA).

3.2 Hydrologic characteristics

Small streams in the Clam Bayou basin drain south towards Clam Bayou before discharging into Boca Ciego Bay and eventually the Gulf of Mexico. Clam Bayou is contained by several barrier islands and is a habitat restoration and stormwater treatment area. The streams have low reliefs, with elevations ranging from 0 to 1.7 meters mean sea elevation. The area is highly developed and most water entering the streams and bayou come from urban drainages, specifically urban storm water systems (FDEP 2006). The WBIDs are located in south Pinellas County, which has been designated as a Water Use Caution Area, because of the susceptibility for issues pertaining to water shortages and saltwater intrusion from intense groundwater withdrawal (FDEP 2006). Lake Maggiore is located west of WBID 1716C and its small, contributing watershed is predominantly heavily urbanized. The main lake drainage is through a large, managed canal that flows northeast into Tampa Bay. A small outlet on the west side of the lake connects Lake Magiorre to

Clam Bayou, but stormwater models from the City of St. Petersburg indicates that this connection only occurs during 100-year 24-hour storm events. Therefore, Lake Maggiore is not considered to be contributing to WBID 1716C.

Much of the development occurred prior to stormwater regulations, which has caused increases of trash, sediments, and pollutants to enter Clam Bayou. Because of this, Clam Bayou has been selected as an ecosystem restoration project site. The project will create seven sites that cover 44 acres which will treat stormwater coming from the developed areas. The ponds being created will filter pollutants before the water reaches the bay, and will also restore 24 acres of estuarine and coastal habitat.

3.3 Land Use

The four impaired WBIDs in Clam Bayou are highly developed (Figure 3.1 and Table 3.2). WBIDs 1716A and 1716B have greater than 95 percent high intensity urban development within their boundaries. WBIDs 1716C and 1716D have approximately 75 percent and 56 percent high intensity development, respectively. In WBIDs 1716C and 1716D, the second most common land use occurrence is open water at 10 percent and 17 percent of the land use, respectively. Overall, only a small portion of the WBIDs have wetland land uses, with the exception of WBID 1716D. There are no forested, agricultural, mines, or clear cut land uses within the WBIDs, with the exception of WBID 1716C which has a small amount of forested land. The forested and wetland areas within the basin are located within WBIDs 1716C and 1716D, which encompass the Clam Bayou Nature Park.

The actual drainage area of the Clam Bayou varies from the WBID boundaries (Figure 3.2). The United States Geological Survey National Hydrography Dataset was used to delineate the drainage area. The land use composition for the drainage area of WBID 1716A, denoted by the boundary of subwatershed 1043 in Figure 3.2, was comprised mainly of high intensity development at 97 percent. The remaining land use is made up of small regions of golf courses, wetlands, and open water (Table 3.2). Very little differences occurred in land use distribution between the boundary for WBID 1716B and its drainage area (subwatershed 1044), which contains developed and open water land use, exclusively. The only difference was a decrease in acreage in developed land use within the drainage area, and the WBID boundary itself, of about 17 percent. The impaired water quality stations (5.1) in WBID 1716C are located within a small canal in the northern tip of WBID 1716C. A large portion of the WBID does not drain to this canal, and the drainage area for the impaired section of WBID 1716C is approximately 50 percent smaller than the actual WBID boundary. Over 90 percent of the contributing watershed is urbanized. In WBID 1716D, the drainage area is much greater than the actual WBID and includes discharges from WBID 1716A, 1716B, and 1716C. The contributing area is heavily urbanized, and over 90 percent is classified as high intensity developments.

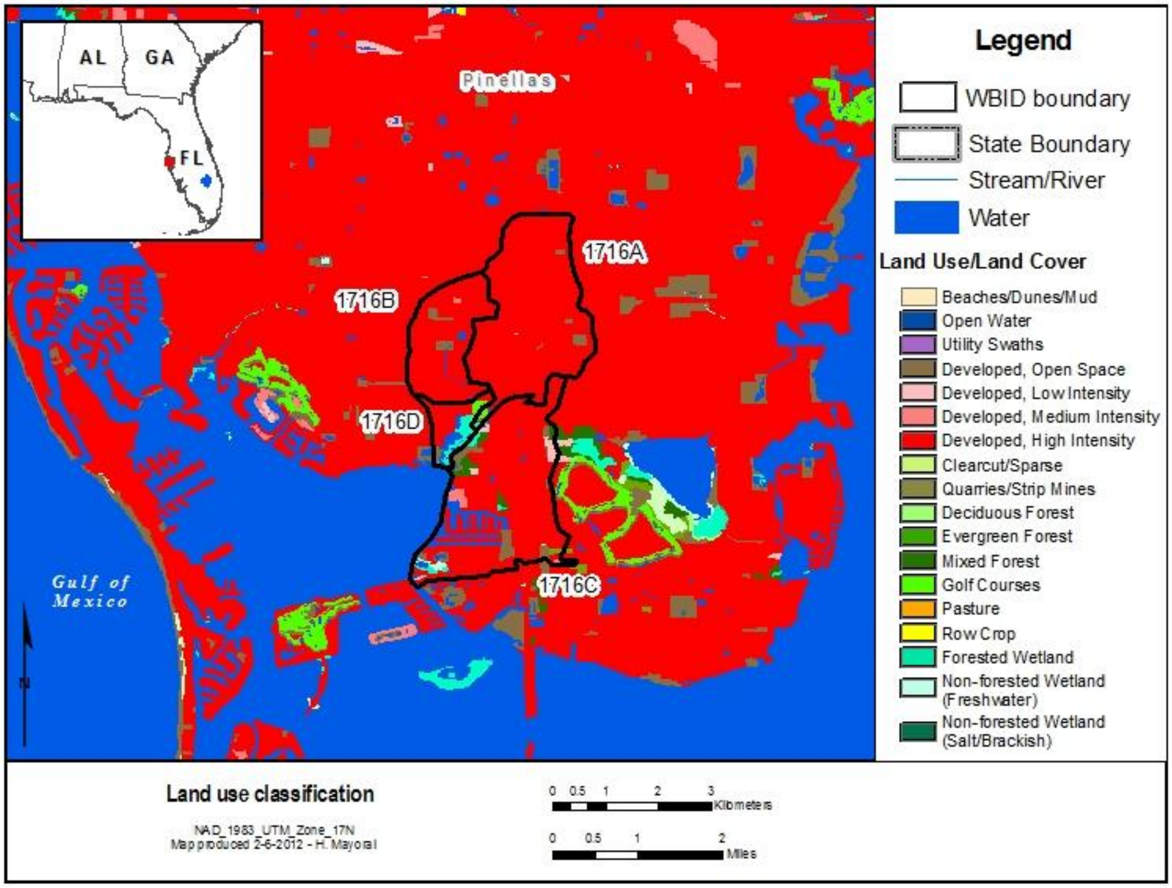

Figure 3.1 Land use for the impaired WBIDs in the Clam Bayou basin.

Table 3.1 Land use distribution for the impaired WBIDs in the Clam Bayou basin.

Land Use Classification	1716A		1716B		1716C		1716D	
	Acres	%	Acres	%	Acres	%	Acres	%
Beaches/Dunes/Mud	0	0%	0	0%	0	0%	0	0%
Evergreen Forest	0	0%	0	0%	6	0%	0	0%
Deciduous Forest	0	0%	0	0%	0	0%	0	0%
Mixed Forest	0	0%	0	0%	46	3%	0	0%
Forested Wetland	4	0%	0	0%	24	2%	35	17%
Non-Forested Wetland (Freshwater)	0	0%	0	0%	10	1%	0	0%
Open Water	2	0%	10	2%	147	10%	35	17%
Pasture	0	0%	0	0%	0	0%	0	0%
Row Crop	0	0%	0	0%	0	0%	0	0%
Golf Courses	10	1%	0	0%	0	0%	12	6%
Clear cut Sparse	0	0%	0	0%	0	0%	0	0%
Quarries Strip mines	0	0%	0	0%	0	0%	0	0%
Developed, Open Space	22	2%	23	4%	75	5%	8	4%
Developed, Low intensity	0	0%	0	0%	29	2%	0	0%
Developed, Medium intensity	0	0%	3	0%	26	2%	0	0%
Developed, High intensity	1,286	97%	587	94%	1,114	75%	114	56%
Totals	1,323	100%	623	100%	1,477	100%	205	100%

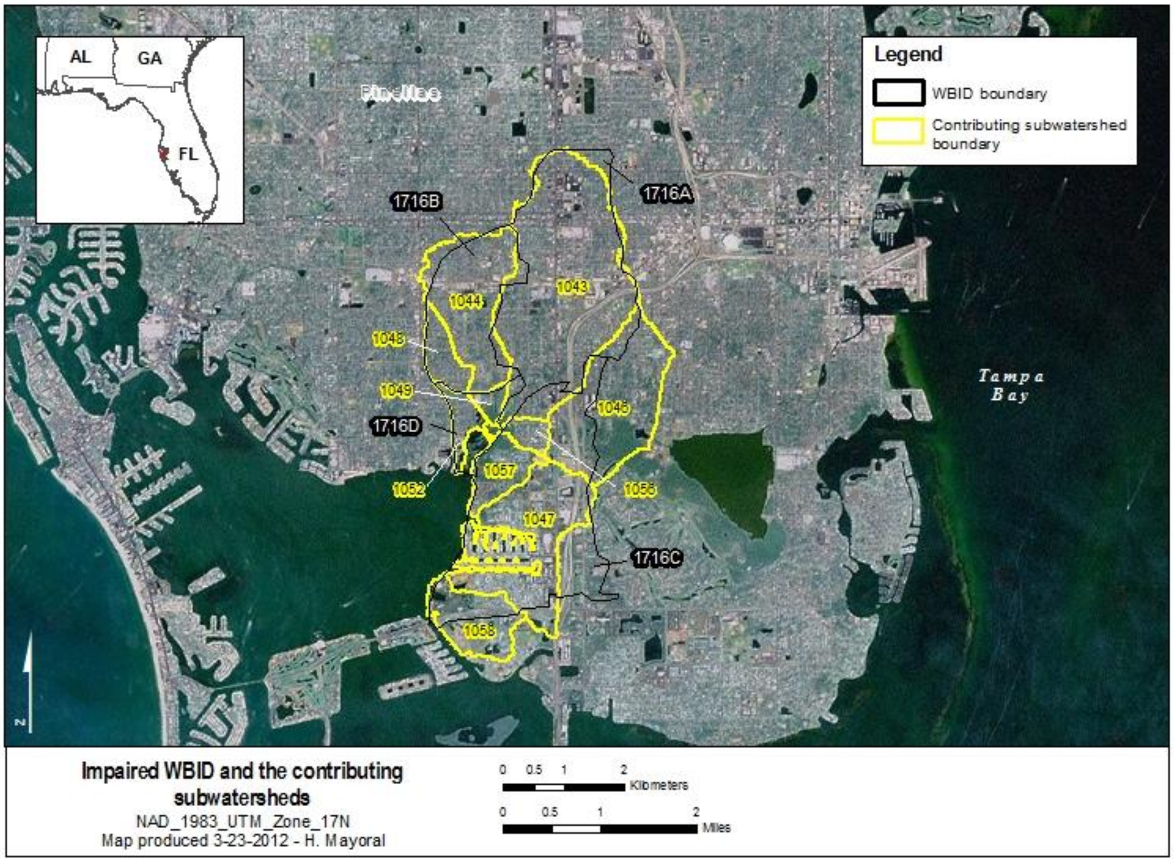

Figure 3.2 Aerial photo illustrating contributing subwatershed boundaries and impaired WBIDs.

Table 3.2 Land use distribution for contributing subwatersheds in the Clam Bayou basin.

Land Use Classification	Contributing subwatersheds for WBID 1716A		Contributing subwatersheds for WBID 1716B		Contributing subwatersheds for WBID 1716C		Contributing subwatersheds for WBID 1716D	
	Acres	%	Acres	%	Acres	%	Acres	%
Beaches, Dunes or Mud	0	0%	0	0%	0	0%	0	0%
Evergreen Forest	0	0%	0	0%	0	0%	0	0%
Deciduous Forest	0	0%	0	0%	0	0%	0	0%
Mixed Forest	0	0%	0	0%	62	8%	62	2%
Forested Wetland	4	0%	0	0%	32	4%	48	2%
Non-Forested Wetland (Freshwater)	0	0%	0	0%	0	0%	0	0%
Open Water	3	0%	10	2%	9	1%	31	1%
Pasture	0	0%	0	0%	0	0%	0	0%
Row Crop	0	0%	0	0%	0	0%	0	0%
Golf Courses	16	1%	0	0%	4	1%	27	1%
Clear cut Sparse	0	0%	0	0%	0	0%	0	0%
Quarries Strip mines	0	0%	0	0%	0	0%	0	0%
Developed, Open Space	22	2%	23	4%	7	1%	60	2%
Developed, Low intensity	0	0%	0	0%	40	5%	40	1%
Developed, Medium intensity	0	0%	3	1%	0	0%	3	0%
Developed, High intensity	1,311	97%	487	93%	589	79%	2,614	91%
Totals	1,357	100%	523	100%	744	100%	2,885	100%

4.0 WATER QUALITY STANDARDS/TMDL TARGETS

The TMDL reduction scenarios were done to achieve Florida's dissolved oxygen concentration of 5 mg/L and ensure balanced flora and fauna within these WBIDs or establish the TMDL to be consistent with a natural condition if the dissolved oxygen standard cannot be achieved.

4.1 Designated Uses

Florida has classified its waters based on the designated uses those waters are expected to support. Waters classified as Class I waters are designated for Potable Water Supply; Class II waters are designated for Shellfish Propagation or Harvesting, and Class III waters are designated for Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife. Designated use classifications are described in Florida's water quality standards at section 62-302.400, F.A.C.

The waterbodies addressed in this report are Class III waters. WBIDs 1716A, 1716B, 1716C, and 1716D are Class III Freshwater and Marine. Clam Bayou is also an Outstanding Florida Water. State provisions regarding Outstanding Florida Waters are set out in Section 62-302.700, F.A.C. and Rule 62-4.242(2) and (3), F.A.C.

4.2 Water Quality Criteria

Water quality criteria for protection of all classes of waters are established in Section 62-302.530, F.A.C. Individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C., which established minimum criteria that apply to all waters unless alternative criteria are specified. Section 62-302.530, F.A.C. While FDEP does not have a streams water quality standard specifically for chlorophyll *a*, elevated levels of chlorophyll *a* are frequently associated with nonattainment of the narrative nutrient standard, which is described below.

4.3 Nutrient Criteria

In 1979, FDEP adopted a narrative criterion for nutrients. FDEP recently adopted numeric nutrient criteria for many Class III waters in the state, including streams, lakes, springs, and estuaries, which numerically interprets part of the state narrative criterion for nutrients. On November 30, 2012, EPA approved those criteria as consistent with the requirements of the CWA. Estuary specific criteria for a number of estuaries, as set out in 62-302.532(1), are effective for state law purposes. The remainder of the state criteria, however, are not yet effective for state law purposes.

In December 2010, EPA promulgated numeric nutrient criteria for Class I/III inland waters in Florida, including lakes and streams. On February 18, 2012, the federally promulgated criteria for lakes and springs were upheld by the U.S. District Court for the Northern District of Florida. Those criteria became effective on January 7, 2013. The Court invalidated the streams criteria and remanded those criteria back to EPA. EPA reproposed the streams criteria on November 30, 2012.

Therefore, for lakes and springs in Florida, the applicable nutrient water quality criteria for CWA purposes are the federally promulgated criteria. For those estuaries identified in 62-302.532(1), the applicable nutrient water quality criteria for CWA purposes are FDEP's estuary criteria. For streams and the remaining estuaries in Florida, the applicable nutrient water quality standard for CWA purposes remains Florida's narrative nutrient criterion.

4.3.1 Narrative Nutrient Criteria

Florida's narrative nutrient criteria for Class I, II, and III waters provide:

> The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter. Man induced nutrient enrichment (total nitrogen and total phosphorus) shall be considered degradation in relation to the provisions of Sections 62-302.300, 62-302.700, and 62-4.242. Section 62-302.530(47)(a), F.A.C.
>
> In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna. Section 62-302.530(47)(b), F.A.C.

Chlorophyll and DO levels are often used to indicate whether nutrients are present in excessive amounts. The target for this TMDL is based on levels of nutrients necessary to prevent violations of Florida's DO criterion, set out below.

4.3.2 Inland Nutrient Criteria for streams

Florida's recently adopted numeric nutrient criteria interprets the narrative water quality criterion for nutrients in paragraph 62-302.530(48)(b), F.A.C. See section 62-302.531(2). While not yet effective as water quality criteria, the FDEP's numeric nutrient criteria represent the state's most recent interpretation of the second part of Florida's narrative criteria, set out at paragraph 62-302.530(47)(b), F.A.C. See section 62-302.531(2). Unless otherwise stated, where the EPA refers to the state nutrient rule in this TMDL, that rule is referenced as the state's interpretation of the narrative criterion. In addition, the first part of the narrative criteria, at paragraph 62-302.530(47)(a), F.A.C., also remains applicable to all Class I, II and III waters in Florida.

Florida's rule applies to streams. For streams that do not have a site specific criteria, Florida's rule provides for biological information to be considered together with nutrient thresholds to determine whether a waterbody is attaining 62-302.531(2)(c), F.A.C. The rule provides that the nutrient criteria are attained in a stream segment where information on chlorophyll a levels, algal mats or blooms, nuisance macrophyte growth, and changes in algal species composition indicates there are no imbalances in flora and either the average score of at least two temporally independent SCIs performed at representative locations and times is 40 or higher, with neither of the two most recent SCI scores less than 35, or the nutrient thresholds set forth in Table 1 below are achieved. See section 62-302.531(2)(c).

Florida's rule provides that numeric nutrient criteria are expressed as a geometric mean, and concentrations are not to be exceeded more than once in any three calendar year period. Section 62-302.200 (25)(e), F.A.C.

Table 4.1 Inland numeric nutrient criteria

Nutrient Watershed Region	Total Phosphorus Nutrient Threshold	Total Nitrogen Nutrient Threshold
Panhandle West	0.06 mg/L	0.67 mg/L
Panhandle East	0.18 mg/L	1.03 mg/L
North Central	0.30 mg/L	1.87 mg/L
Peninsular	0.12 mg/L	1.54 mg/L

West Central	0.49 mg/L	1.65 mg/L
South Florida	No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies.	No numeric nutrient threshold. The narrative criterion in paragraph 62-302.530(47)(b), F.A.C., applies.

4.3.3 Inland Nutrient Criteria for estuaries with effective criteria

Numeric criteria for estuaries are expressed as either concentration-based estuary interpretations that are open water, area-wide averages or as load per million cubic meters of freshwater inflow that are the total load of that nutrient to the estuary divided by the total volume of freshwater inflow to that estuary. The criteria are set out at 62-302.532(1).

4.3.4 Inland Nutrient Criteria for lakes

Federal water quality criteria for lakes set out at 40 CFR 131.43(c)(1). The criteria are expressed as concentrations of chlorophyll a, total phosphorus, and total nitrogen as follows:

Lake Color and Alkalinity	Chl-a (mg/L)*	TN (mg/L)	TP (mg/L)
Colored Lakes (Long-term Color > 40 Platinum Cobalt Units (PCU)	0.020	1.27 [1.27-2.23]	0.05 [0.05-0.16]
Clear Lakes, High Alkalinity (Long-term Color ≤ 40 PCU and Alkalinity > 20 mg/L $CaCO_3$)	0.020	1.05 [1.05-1.91]	0.03 [0.03-0.09]
Clear Lakes, Low Alkalinity (Long-term Color ≤ 40 PCU and Alkalinity ≤ 20 mg/L $CaCO_3$)	0.006	0.51 [0.51-0.93]	0.01 [0.01-0.03]

* For a given waterbody, the annual geometric mean of chlorophyll *a*, TN or TP concentrations shall not exceed the applicable criterion concentration more than once in a three-year period.

4.3.5 Springs Nutrient Criteria

The numeric criteria for spring is 0.35 mg/L of nitrate-nitrite as an annual geometric mean, not to be exceeded more than once in any three year period.

4.4 Dissolved Oxygen Criteria

Numeric criteria for DO are expressed in terms of minimum and daily average concentrations. While FDEP has adopted revised DO criteria for freshwaters, these revisions have not yet been submitted to EPA for review. Therefore, the applicable criterion for Clean Water Act purposes remains subsection 62-302.530(30), F.A.C.

For Class I and Class III freshwaters, subsection 62-302.530(30) provides as follows:
Shall not be less than 5.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained. [FAC 62-302.530 (30)]

For Class III marine waters, subsection 62-302.530(30) provides as follows:

Shall not average less than 5.0 mg/L in a 24-hour period and shall never be less than 4.0 mg/L. Normal daily and seasonal fluctuations above these levels shall be maintained. [FAC 62-302.530 (30)]

4.5 Biochemical Oxygen Demand Criteria

Biochemical Oxygen Demand (BOD) shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each class and, in no case, shall it be great enough to produce nuisance conditions. [FAC 62-302.530 (11)]

4.6 Natural Conditions

In addition to the standards for nutrients, DO, and BOD described above, Florida's standards include provisions that address waterbodies which do not meet the standards due to natural background conditions.

Florida's water quality standards provide a definition of natural background:

"Natural Background" shall mean the condition of waters in the absence of man-induced alterations based on the best scientific information available to the Department. The establishment of natural background for an altered waterbody may be based upon a similar unaltered waterbody or on historical pre-alteration data. [FAC 62-302.200(19)]

Florida's water quality standards also provide that:

Pollution which causes or contributes to new violations of water quality standards or to continuation of existing violations is harmful to the waters of this State and shall not be allowed. Waters having water quality below the criteria established for them shall be protected and enhanced. However, the Department shall not strive to abate natural conditions. [FAC 62-302.300(15)]

5.0 WATER QUALITY ASSESSMENT

All of the WBIDs addressed in this report were listed as not attaining their designated use on Florida's 2006 303(d) list for dissolved oxygen and nutrients. To determine impairment, an assessment of available data was conducted. The source for current ambient monitoring data was the Impaired Waters Rule (IWR) data Run 44, using data ranging January 1, 2002 to December 31, 2010. The IWR database contains data from various sources within the state of Florida, including the WMDs and counties.

5.1 Water Quality Data

Table 5.1 lists the water quality stations found in the four WBIDs, and Table 5.2 provides an analysis of the water quality data. Figure 5.1 shows the locations of the water quality monitoring stations within each of the WBIDs. Water quality data for each WBID can be found below in Figures 5.2 through 5.21.

5.1.1 Dissolved Oxygen

There are several factors that affect the concentration of DO in a waterbody. Oxygen can be introduced by wind, diffusion, photosynthesis, and additions of higher DO water (e.g. from tributaries). DO concentrations are lowered by processes that use up oxygen from the water, such as respiration and decomposition, and by additions of water with lower DO (e.g. swamp or groundwater). Natural DO levels are a function of water temperature, water depth and velocity, and relative contributions of groundwater. Decomposition of organic matter, such as dead plants and animals, also consume DO. Minimum dissolved oxygen concentrations in the WBIDs ranged between 0.52 mg/L and 1.74 mg/L, and maximum concentrations ranged between 8.0 mg/L and 11.0 mg/L. Mean DO concentrations ranged between 4.08 mg/L and 5.27 mg/L.

5.1.2 Biological Oxygen Demand

BOD is a measure of the amount of oxygen used by bacteria as they stabilize organic matter. The process can be accelerated when there is an overabundance of nutrients, increasing the aerobic bacterial activity in a waterbody. In turn, the levels of DO can become depleted, eliminating oxygen essential for biotic survival, and potentially causing extensive fish kills. Additionally, BOD is used as an indicator to determine the presence and magnitude of organic pollution from sources such as septic tank leakage, fertilizer runoff, and wastewater effluent. Mean BOD measurements in the WBIDs ranged between 3.23 mg/L and 6.91 mg/L. Minimum concentrations ranged between 0.51 mg/L and 2.0 mg/L, and maximum concentrations were typically 8 mg/L. However, concentrations at 8 mg/L and 2 mg/L, which occurred in WBID 1716A and 1716B, were detection limit values, indicated actual BOD values were likely below these concentrations.

5.1.3 Nutrients

Excessive nutrients in a waterbody can lead to overgrowth of algae and other aquatic plants such as phytoplankton, periphyton and macrophytes. This process can deplete oxygen in the water, adversely affecting aquatic life and potentially restricting recreational uses such as fishing and boating. For the nutrient assessment the monitoring data for total nitrogen, total phosphorus and chlorophyll a are presented. The current standards for nutrients are narrative criteria. The purpose of the nutrient assessment is to present the range, variability and average conditions for the WBID.

5.1.3.1 Total Nitrogen

Total Nitrogen (TN) is comprised of nitrate (NO3), nitrite (NO2), organic nitrogen and ammonia nitrogen (NH4). Though nitrogen is a necessary nutrient required for the growth of most plants and animals, not all forms are readily used or metabolized. Increased levels of organic nitrogen can occur from the decomposition of aquatic life or from sewage, while inorganic forms are generally from erosion and fertilizers. Nitrates are components of industrial fertilizers, yet can also be naturally present in soil, and are converted to nitrite by microorganisms in the environment. Surface runoff from agricultural lands can increase the natural presence of nitrates in the environment and can lead to eutrophication. Total nitrogen minimum concentrations were measured between 0.12 mg/L and 0.68 mg/L for the impaired WBIDs, and maximum concentrations measured between 1.44 mg/L and 2.39 mg/L. Total nitrogen means ranged between 0.74 mg/L and 1.27 mg/L for the WBIDs.

5.1.3.2 Total Phosphorus

In natural waters, total phosphorus exists in either soluble or particulate forms. Dissolved phosphorus includes inorganic and organic forms, while particulate phosphorus is made up of living and dead plankton, and adsorbed, amorphous, and precipitated forms. Inorganic forms of phosphorus include orthophosphate and polyphosphates, though polyphosphates are unstable and convert to orthophosphate over time. Orthophosphate is both stable and reactive, making it the form most used by plants. Excessive phosphorus can lead to overgrowth of algae and aquatic plants, the decomposition of which uses up oxygen from the water. Total phosphorus minimum concentrations ranged between 0.02 mg/L and 0.07 mg/L, and maximum concentrations ranged between 0.13 mg/L and 0.28 mg/L. Mean TP concentrations for all WBIDs were below 0.15 mg/L.

5.1.3.3 Chlorophyll-a

Chlorophyll is the green pigment in plants that allows them to create energy from light. In a water sample, chlorophyll is indicative of the presence of algae, and chlorophyll-*a* is a measure of the active portion of total chlorophyll. Corrected chlorophyll refers to chlorophyll-*a* measurements that are corrected for the presence of pheophytin, a natural degradation product of chlorophyll that can interfere with analysis because it has an absorption peak in the same spectral region. It is used as a proxy indicator of water quality because of its predictable response to nutrient availability. Increases in nutrients can potentially lead to blooms in phytoplankton biomass, affecting water quality and ecosystem health. Corrected chlorophyll-*a* maximum measurements were ranged between 19.5 µg/L and 160.0 µg/l, and means ranging between 4.21µg/L and 27.98 µg/L.

Table 5.1 Water quality data for impaired WBIDs in the Clam Bayou basin.

WBID	Station Number
1716A	21FLPDEM45-03
1716B	21FLPDEM46-03
	21FLPDEM46-01
	21FLGW 35438
	21FLTPA 27450158241217
	21FLTPA 27450868241289
	21FLTPA 27451788241338
1716C	21FLPDEM48-05
	21FLTPA 27444078240537
	21FLTPA 27444078241071
1716D	21FLTPA 27443468241194
	21FLTPA 274414908241375
	21FLTPA 274425108241352

Table 5.2 Water quality data for impaired WBIDs in the Clam Bayou basin.

Parameter	Stats	WBID			
		1716A	1716B	1716C	1716D
BOD, 5 Day, 20°C (mg/L)	# of obs	11	23	13	16
	min	2.00	0.51	3.50	2.00
	max	8.00	8.00	8.10	7.70
	mean	6.91	3.23	5.49	3.56
	Geomean	6.22	1.95	4.24	3.10
DO, Analysis by Probe (mg/L)	# of obs	22	68	37	28
	min	1.74	1.49	0.52	0.54
	max	8.53	10.52	11.30	8.44
	mean	5.04	5.27	4.34	4.08
	Geomean	4.89	4.79	3.83	3.43
Nitrogen, Total (mg/L as N)	# of obs	23	56	31	26
	min	0.68	0.12	0.65	0.51
	max	1.67	2.16	2.39	1.44
	mean	1.21	0.74	1.27	0.87
	Geomean	1.18	0.67	1.24	0.83
Phosphorus, Total (mg/L as P)	# of obs	22	57	32	26
	min	0.02	0.04	0.07	0.04
	max	0.13	0.28	0.28	0.17
	mean	0.06	0.11	0.15	0.09
	Geomean	0.05	0.10	0.14	0.08
Chlorophyll-A-corrected (µg/L)	# of obs	21	57	30	25
	min	2.00	1.00	1.00	4.00
	max	19.50	59.30	160.00	45.00
	mean	4.21	7.57	29.75	15.28
	Geomean	3.35	3.98	16.17	11.56

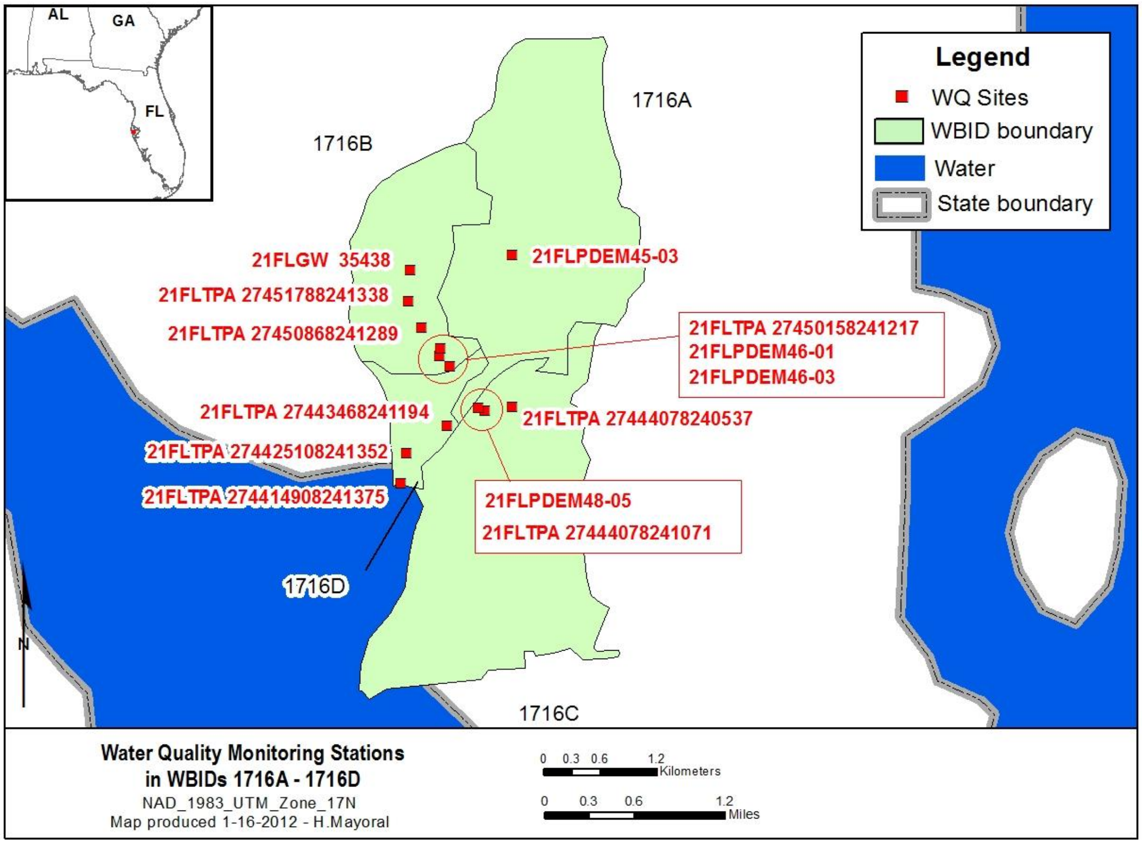

Figure 5.1   Water quality monitoring station locations for WBIDs in the Clam Bayou basin.

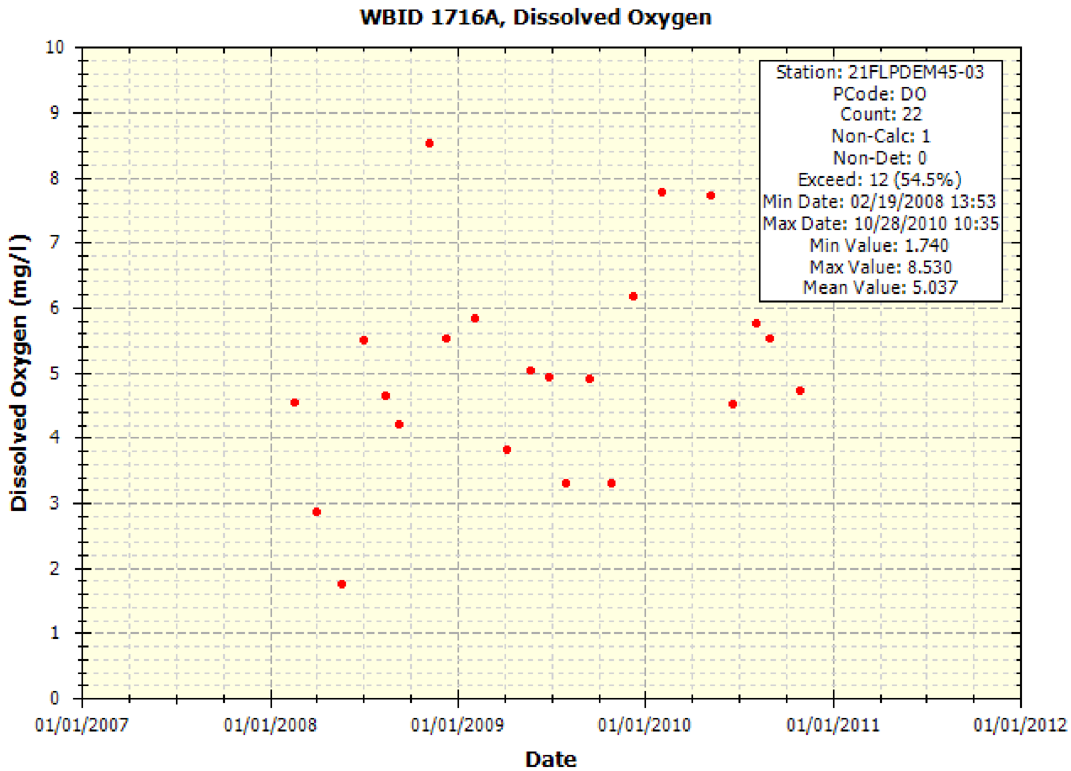

Figure 5.2 Dissolved Oxygen concentrations for WBID 1716A

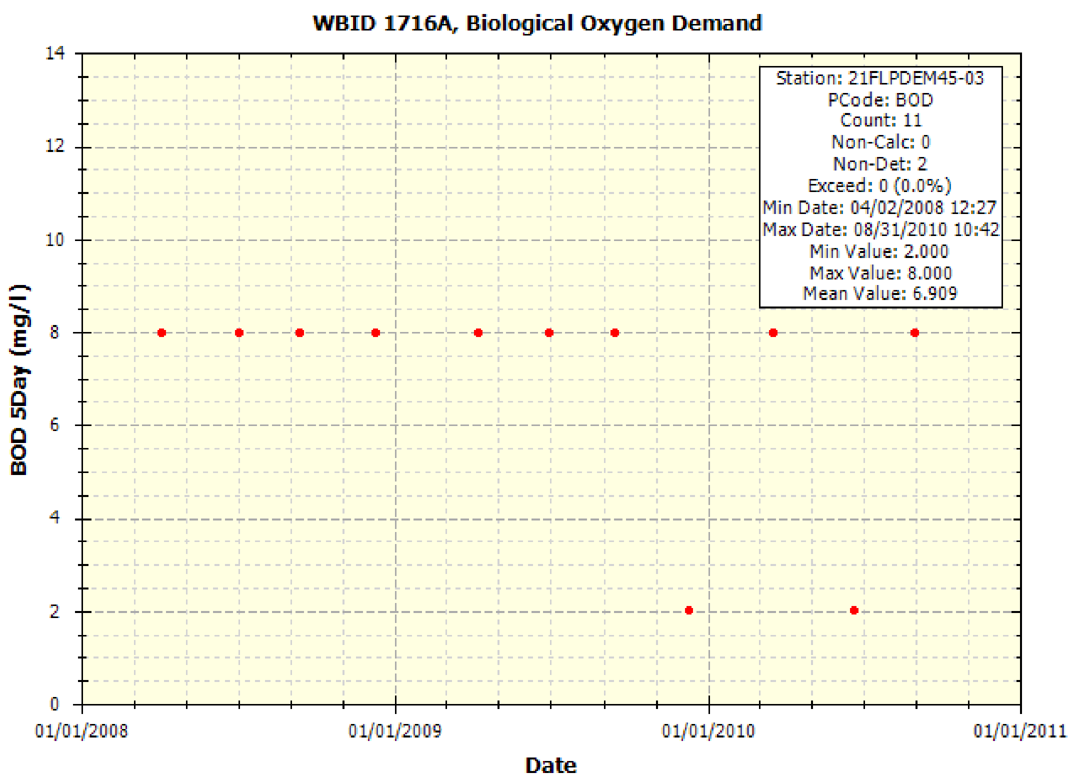

Figure 5.3 Biological Oxygen Demand concentrations for WBID 1716A

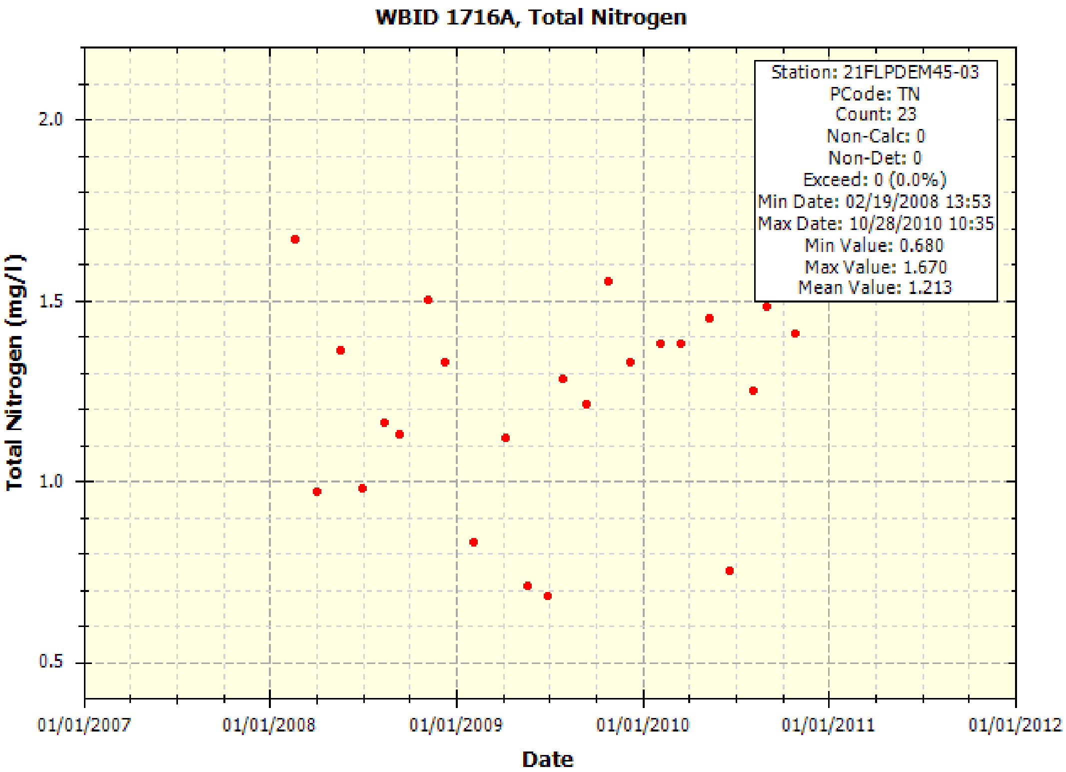

Figure 5.4 Total Nitrogen concentrations for WBID 1716A

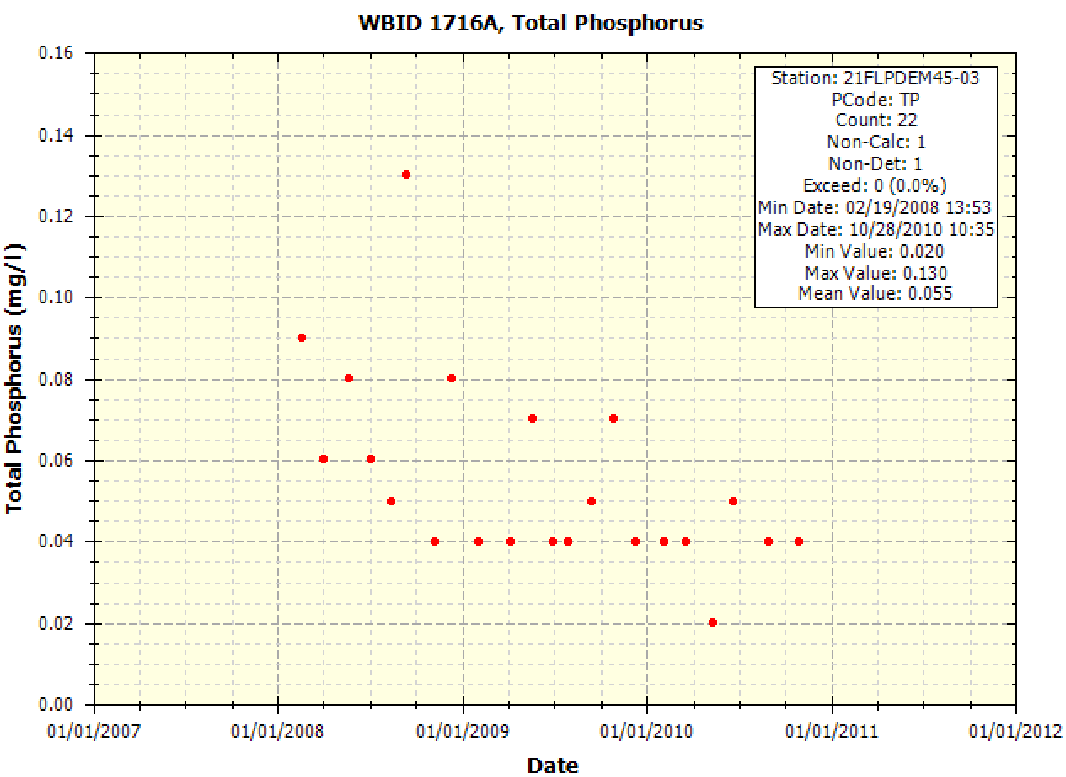

Figure 5.5 Total Phosphorus concentrations for WBID 1716A

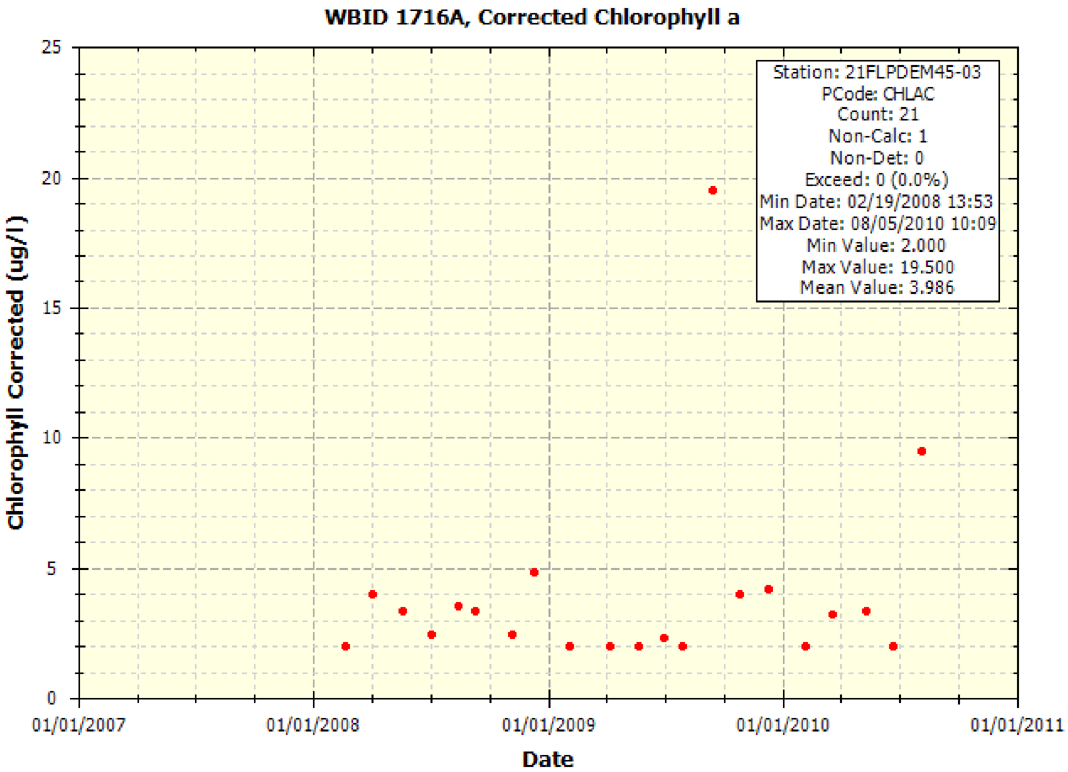

Figure 5.6 Total Phosphorus concentrations for WBID 1716A

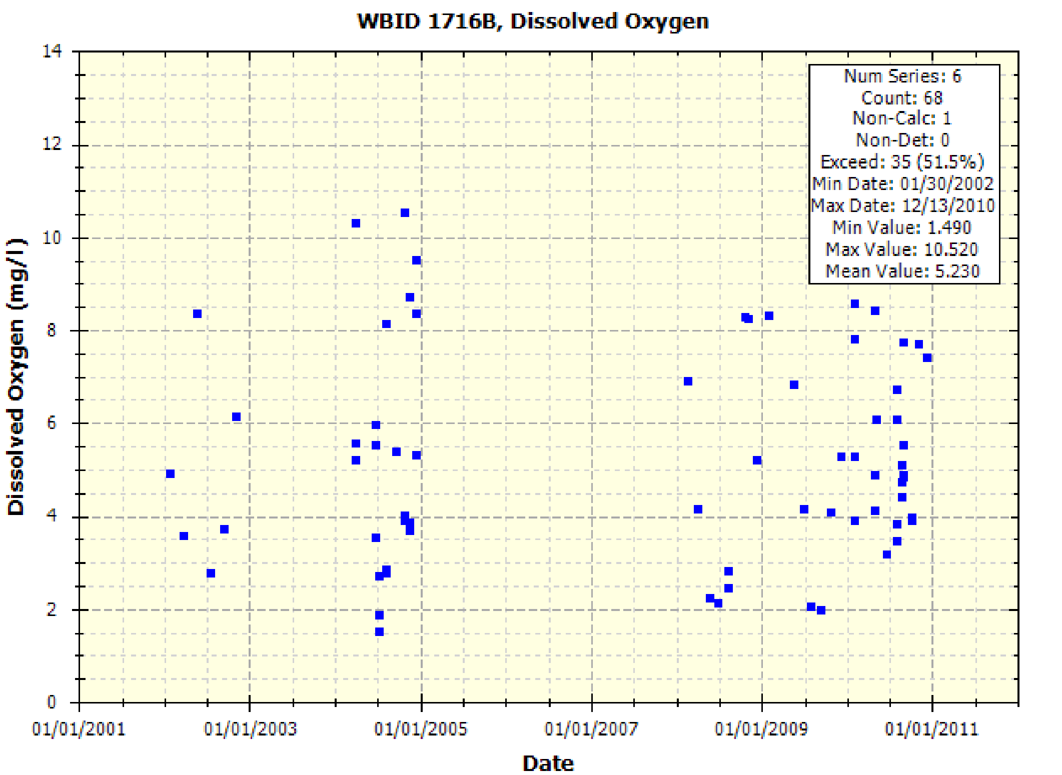

Figure 5.7 Dissolved Oxygen concentrations for WBID 1716B

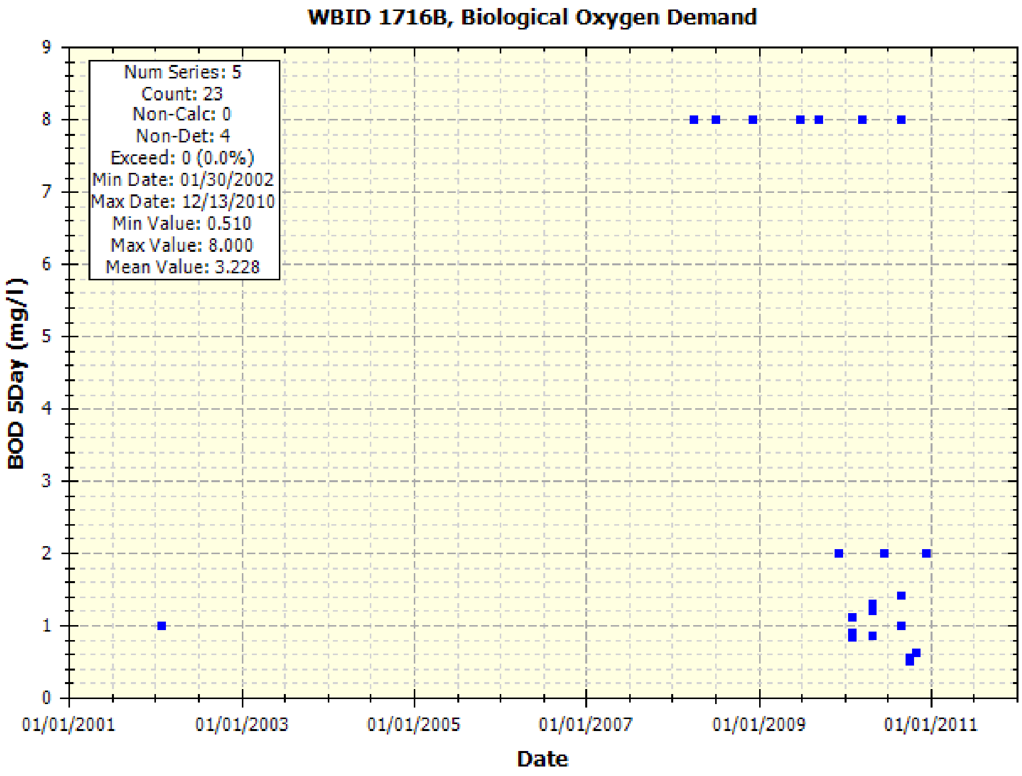

Figure 5.8 Biological Oxygen Demand concentrations for WBID 1716B

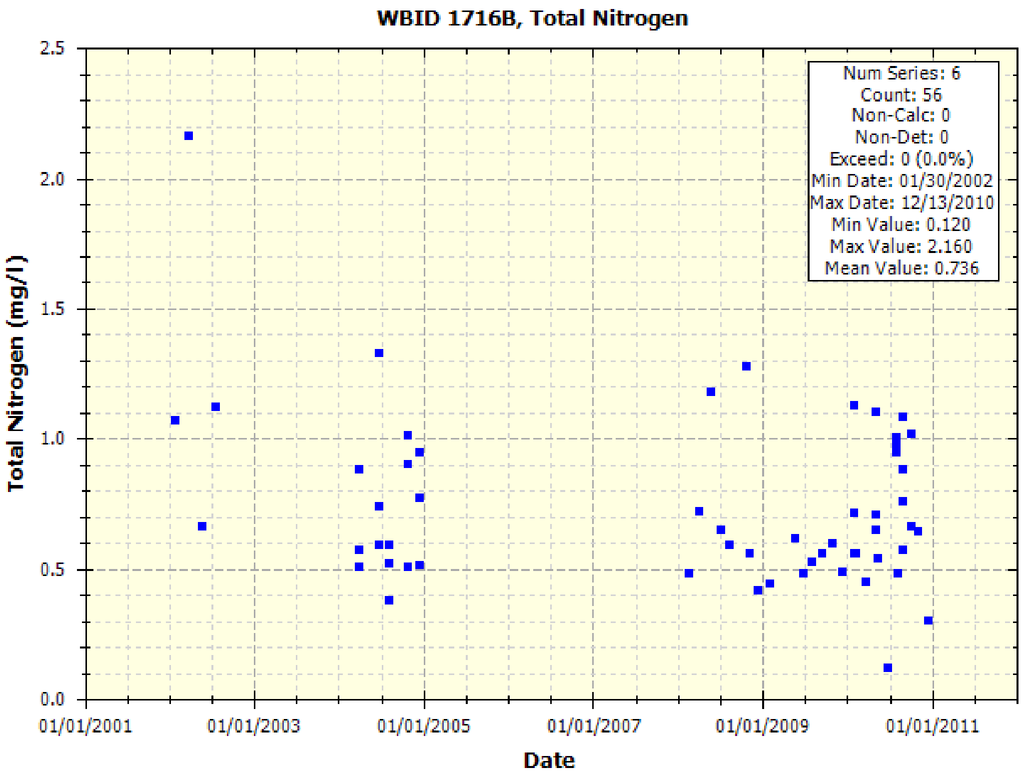

Figure 5.9 Total Nitrogen concentrations for WBID 1716B

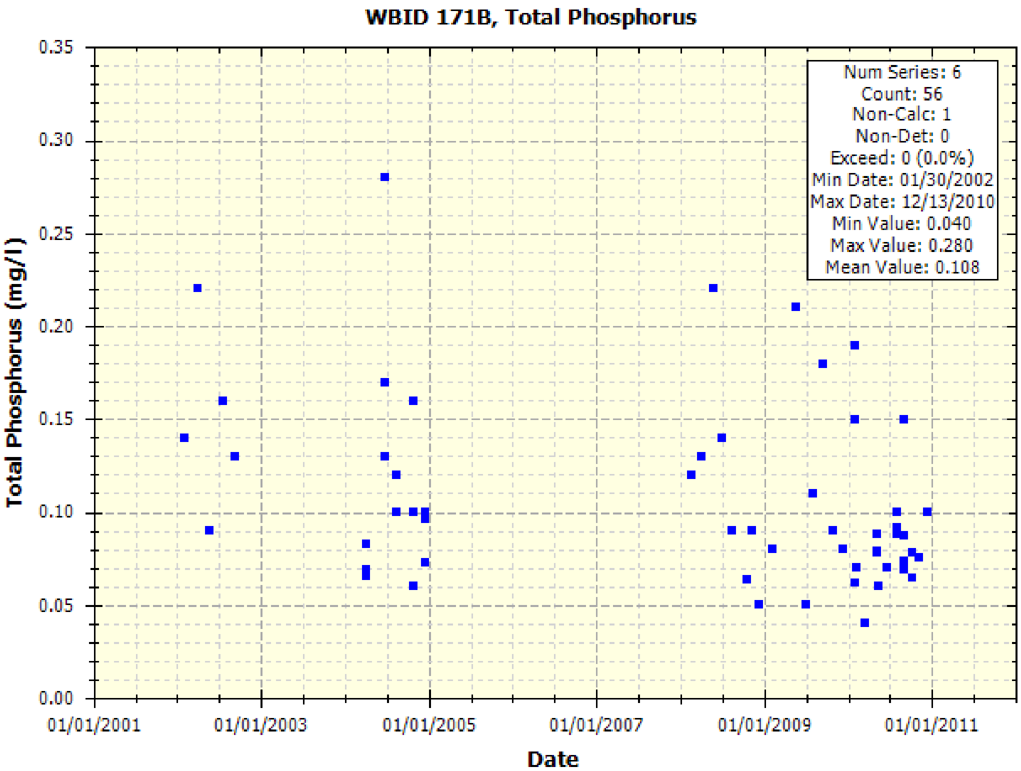

Figure 5.10 Total Phosphorus concentrations for WBID 1716B

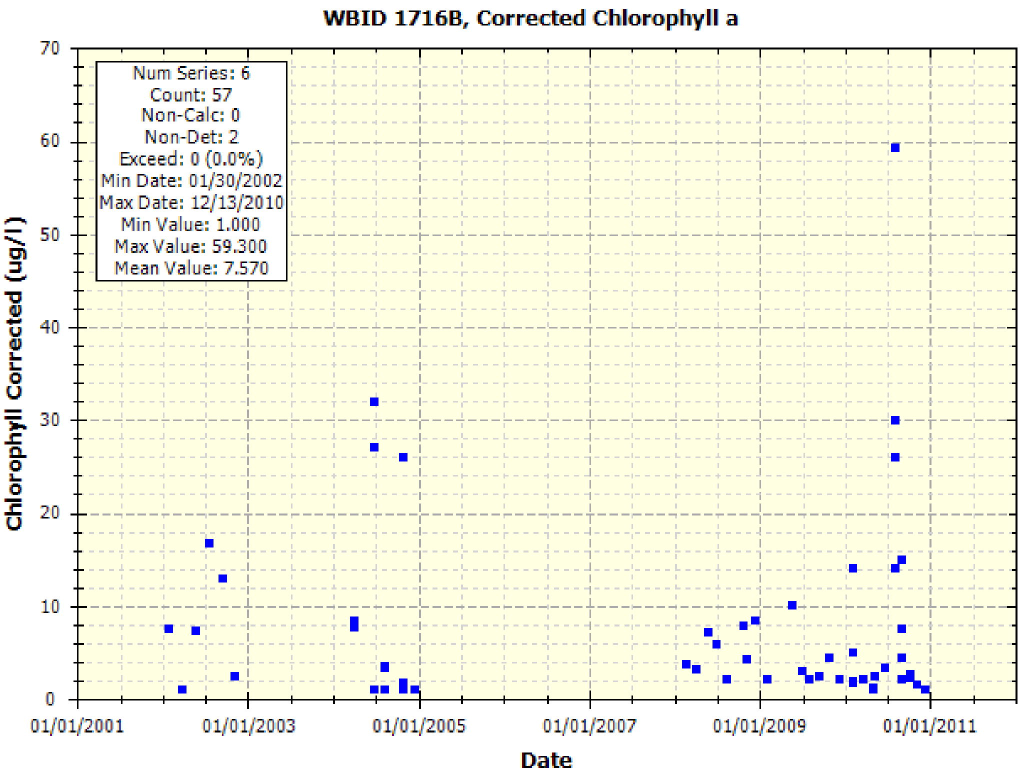

Figure 5.11 Corrected Chlorophyll a concentrations for WBID 1716B

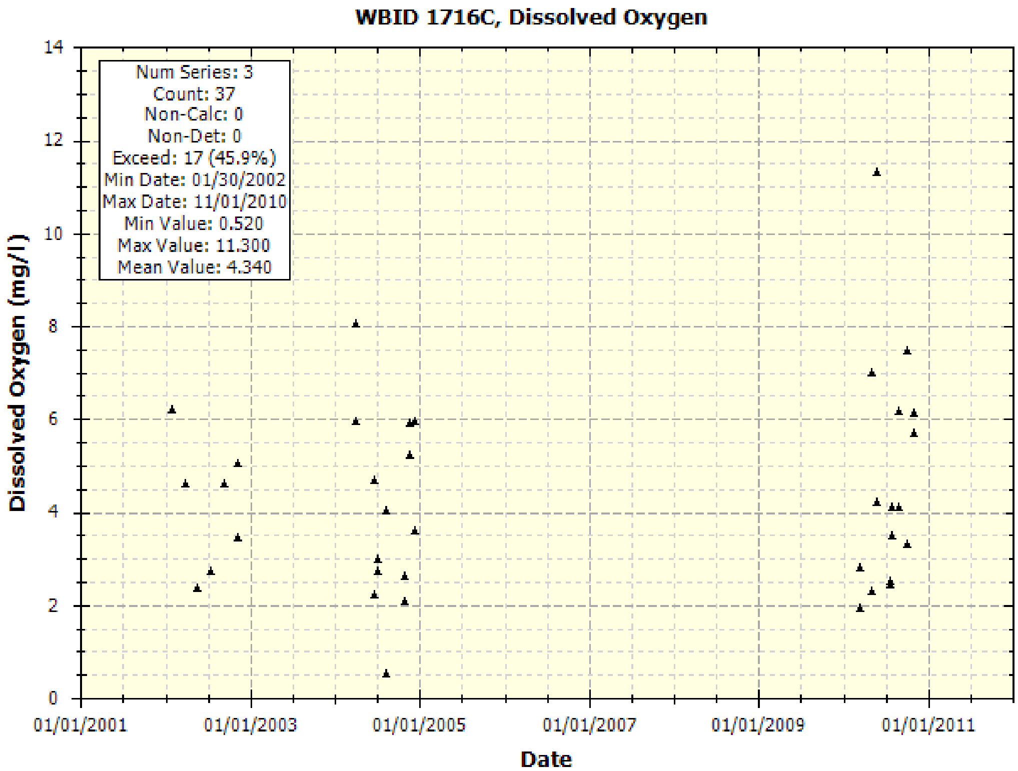

Figure 5.12 Dissolved Oxygen concentrations for WBID 1716C

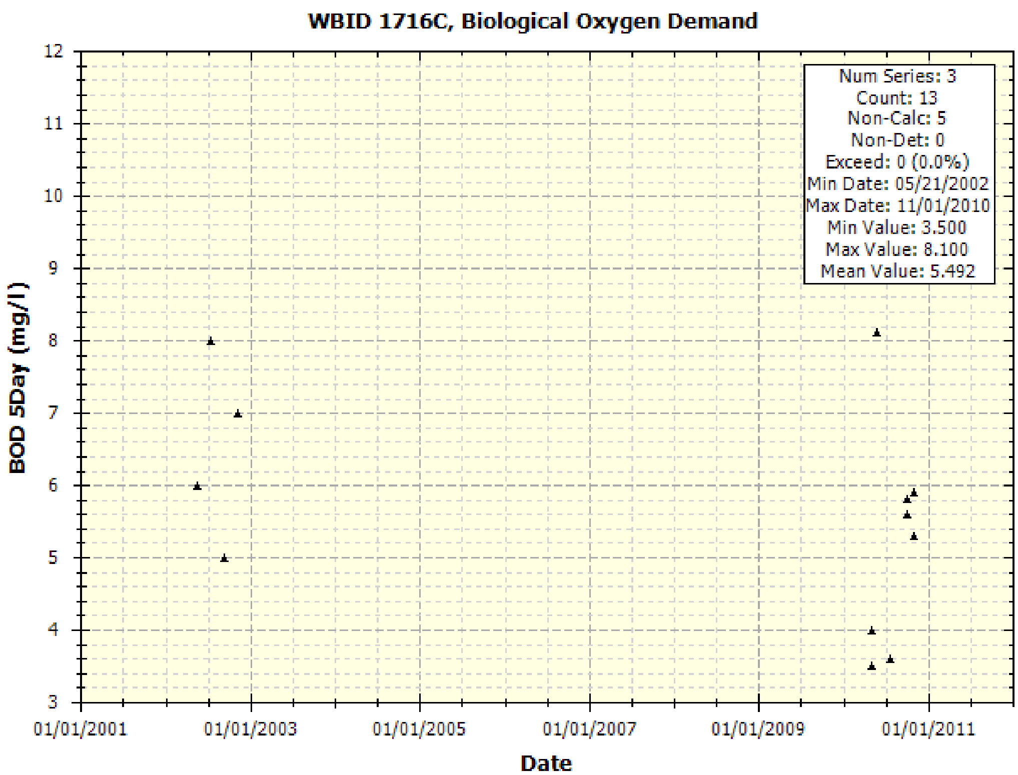

Figure 5.13 Biological Oxygen Demand concentrations for WBID 1716C

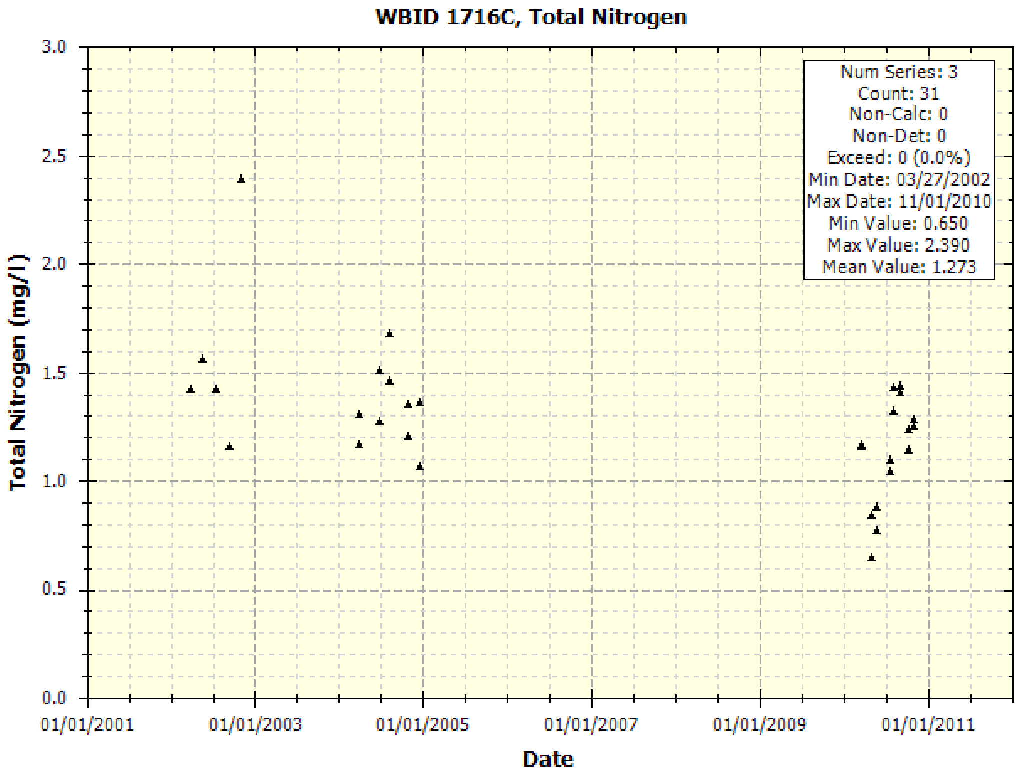

Figure 5.14 Total Nitrogen concentrations for WBID 1716C

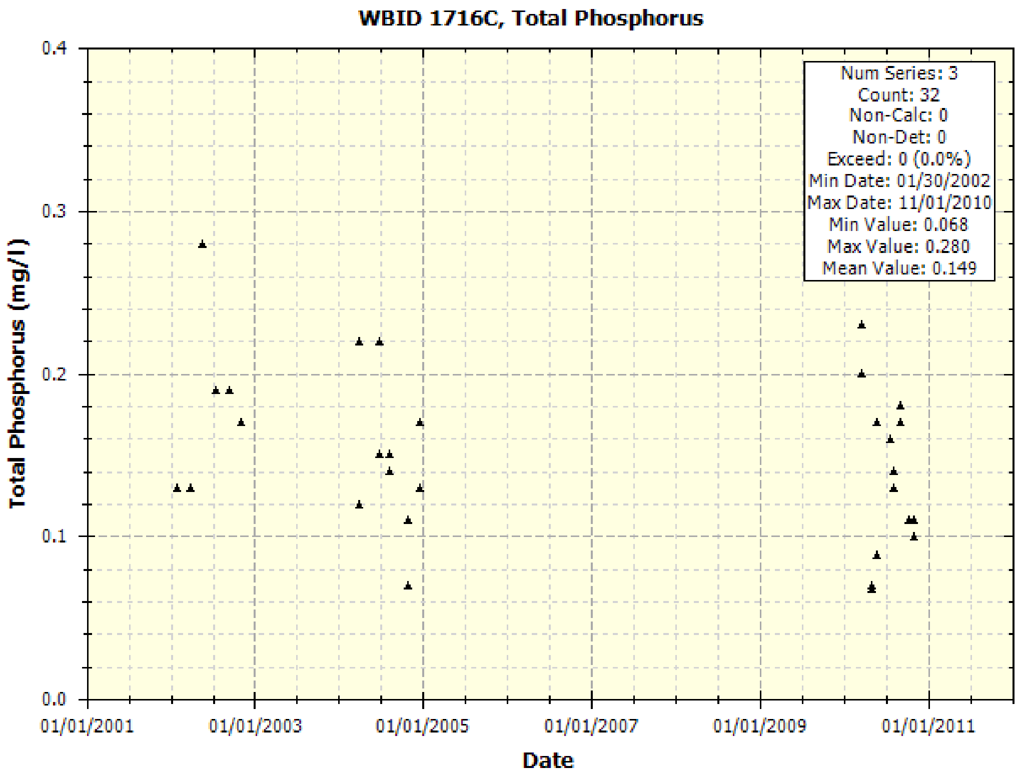

Figure 5.15 Total Phosphorus concentrations for WBID 1716C

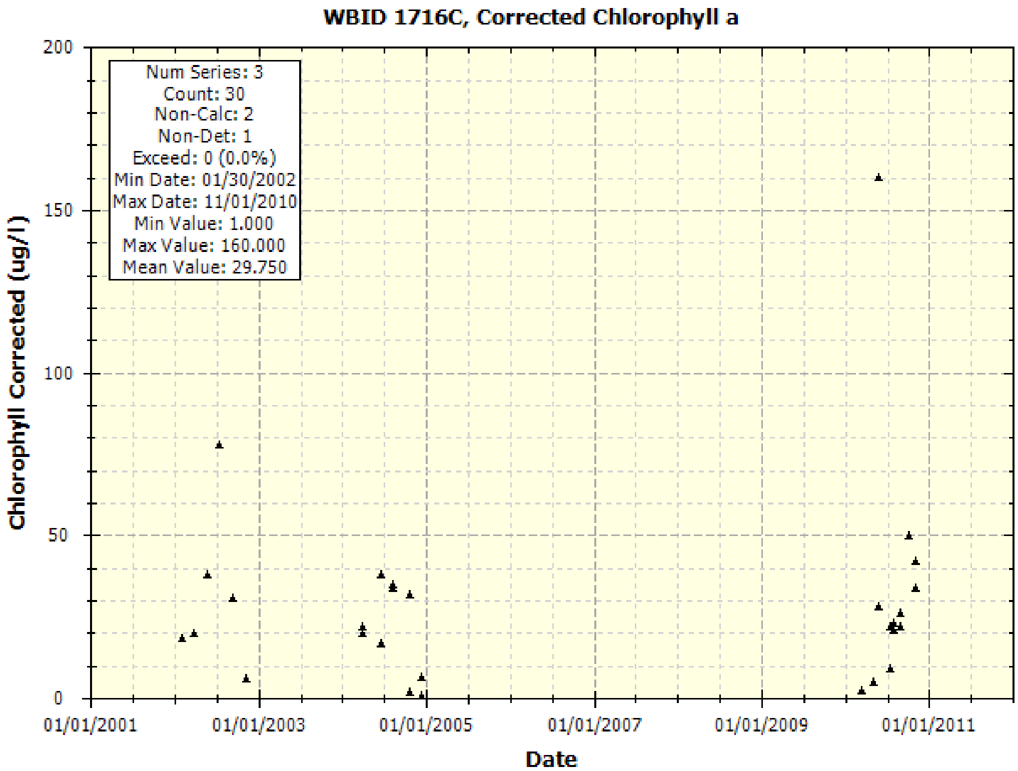

Figure 5.16 Corrected Chlorophyll a concentrations for WBID 1716C

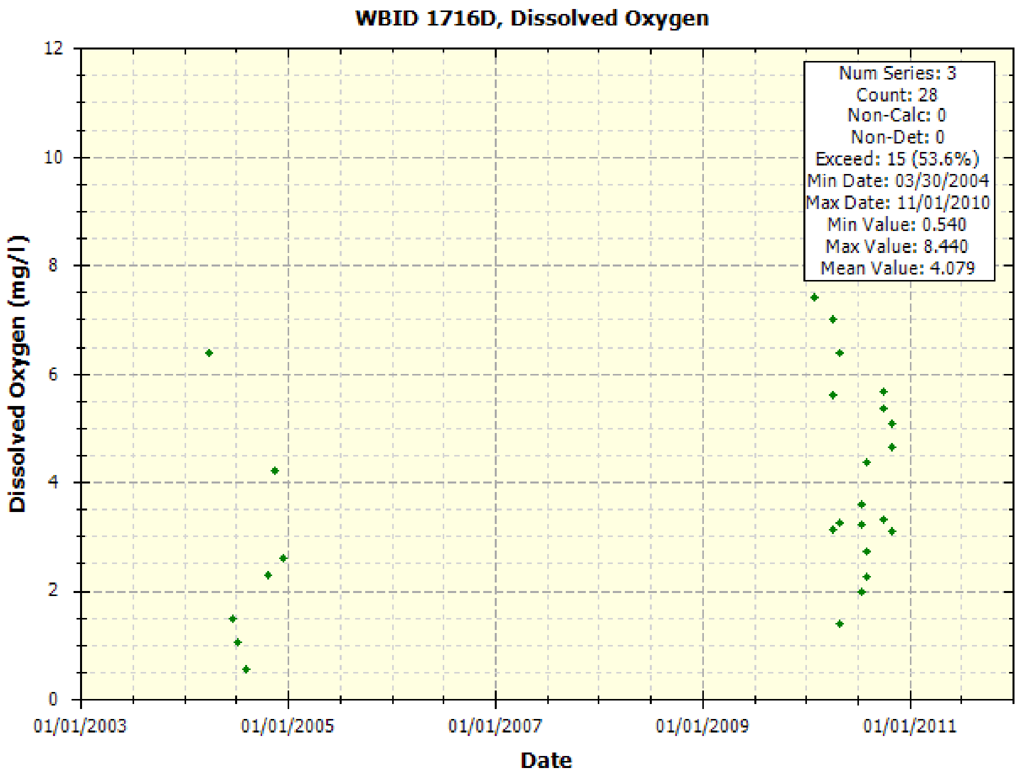

Figure 5.17 Dissolved Oxygen concentrations for WBID 1716D

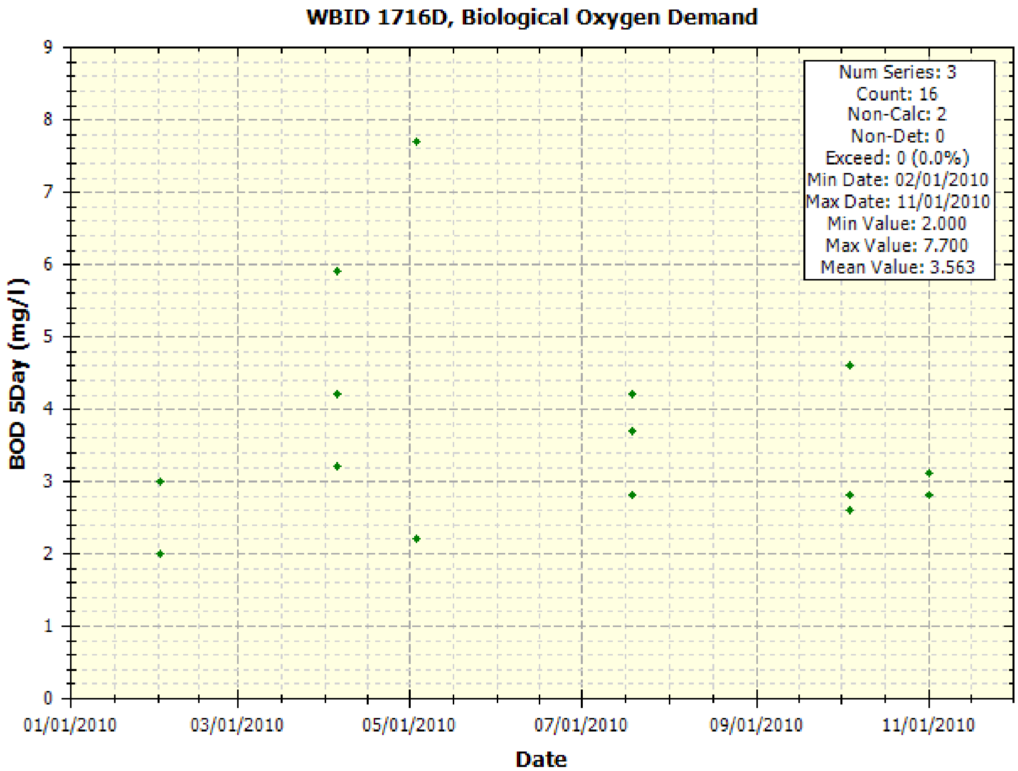

Figure 5.18 Biological Oxygen Demand concentrations for WBID 1716D

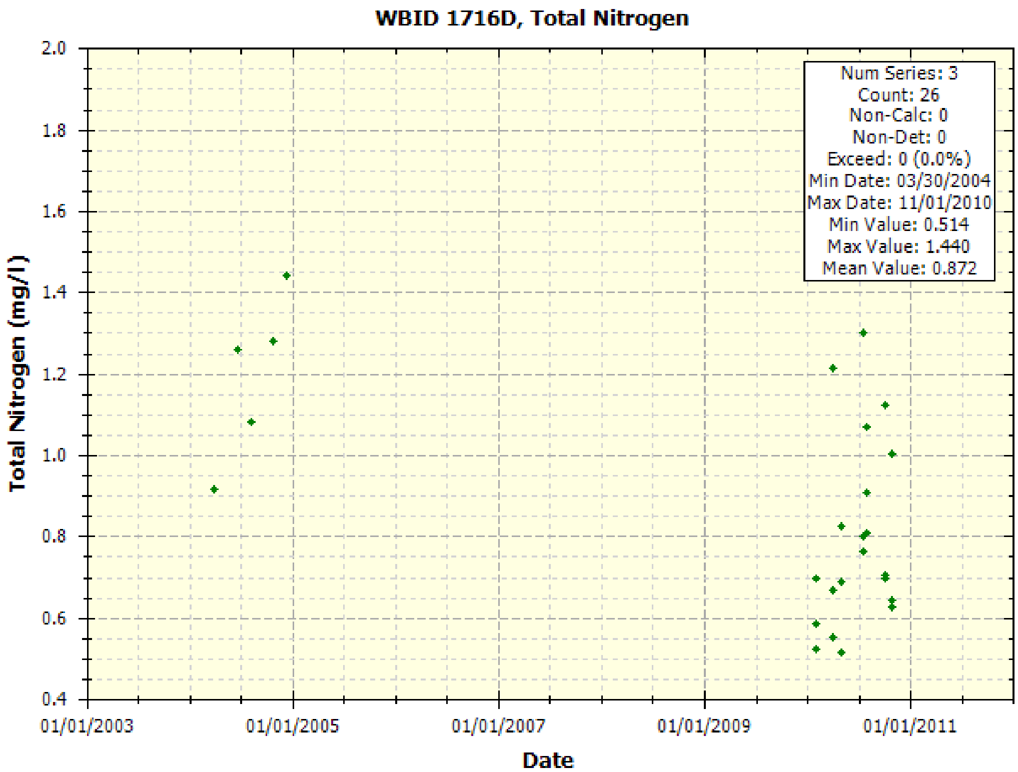

Figure 5.19 Total Nitrogen concentrations for WBID 1716D

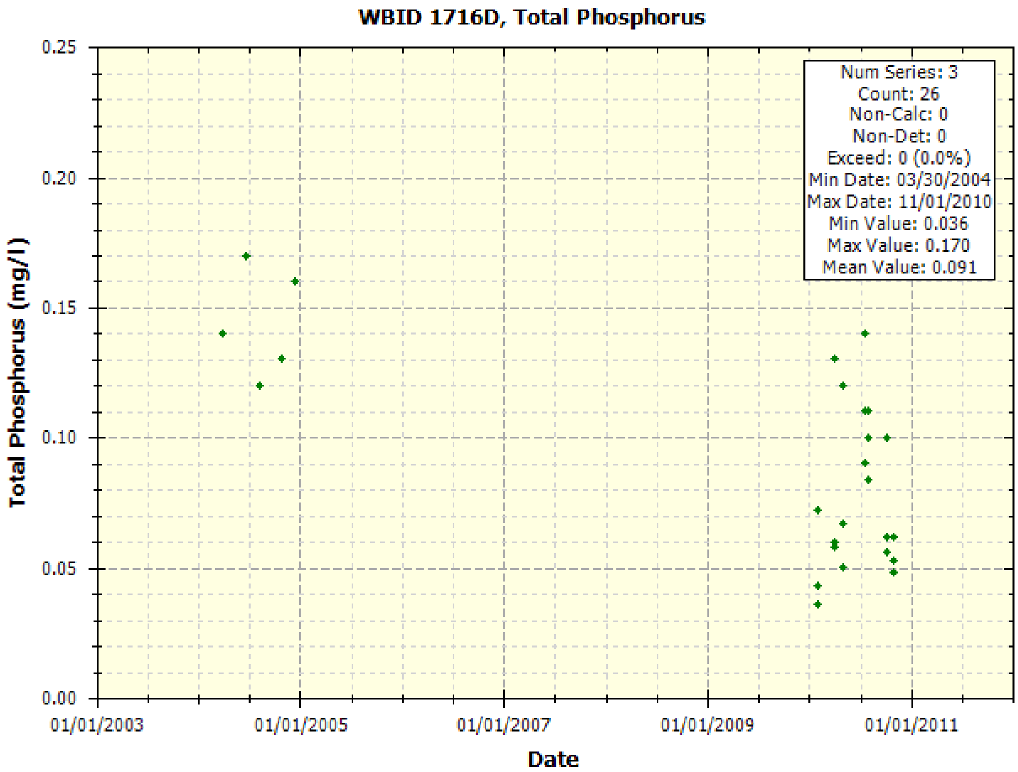

Figure 5.20 Total Phosphorus concentrations for WBID 1716D

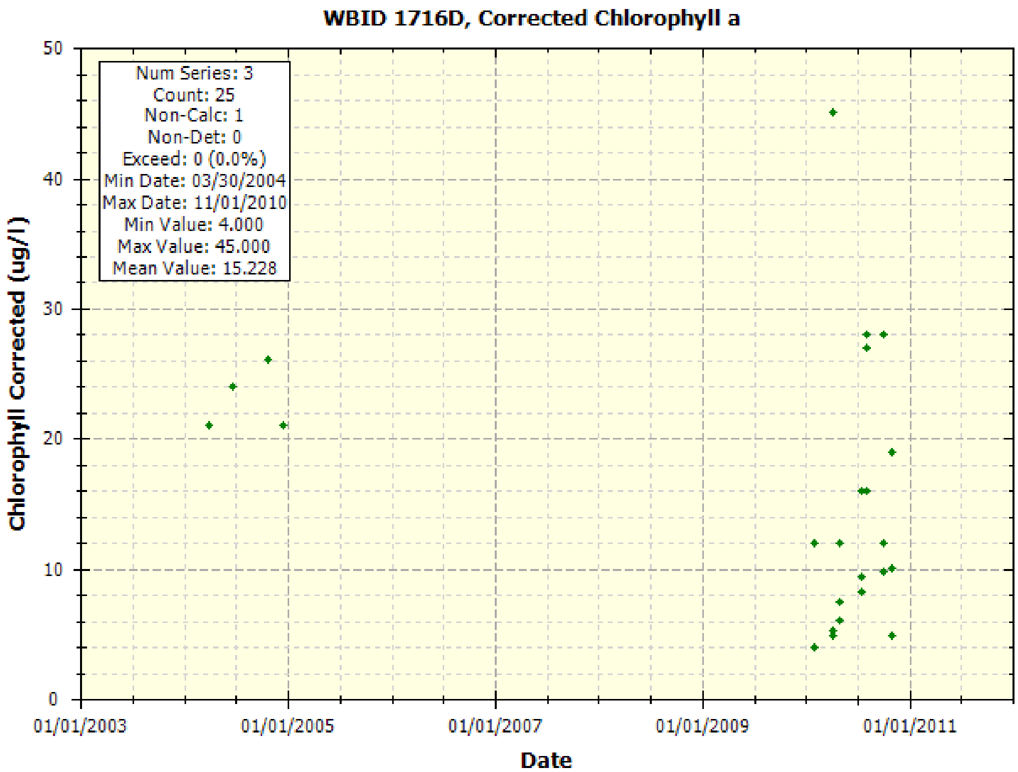

Figure 5.21 Corrected Chlorophyll a concentrations for WBID 1716D

6.0 SOURCE AND LOAD ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of pollutants in the watershed and the amount of loading contributed by each of these sources. Sources are broadly classified as either point or nonpoint sources. Nutrients can enter surface waters from both point and nonpoint sources.

6.1 Point Sources

A point source is defined as a discernible, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted discharges include continuous discharges such as wastewater treatment facilities as well as some stormwater driven sources such as municipal separate storm sewer systems (MS4s), certain industrial facilities, and construction sites over one acre.

6.1.1 Wastewater/Industrial Permitted Facilities

A TMDL wasteload allocation (WLA) is given to wastewater and industrial NPDES permitted facilities discharging to surface waters within an impaired watershed. There is one NPDES-permitted facility in WBID 1716A for Florida Rock Industries, listed in Table 6.1 (see Figure 6.1 for geographic locations). No discharge data was available for the industrial point source and it was not considered a major NPDES discharger.

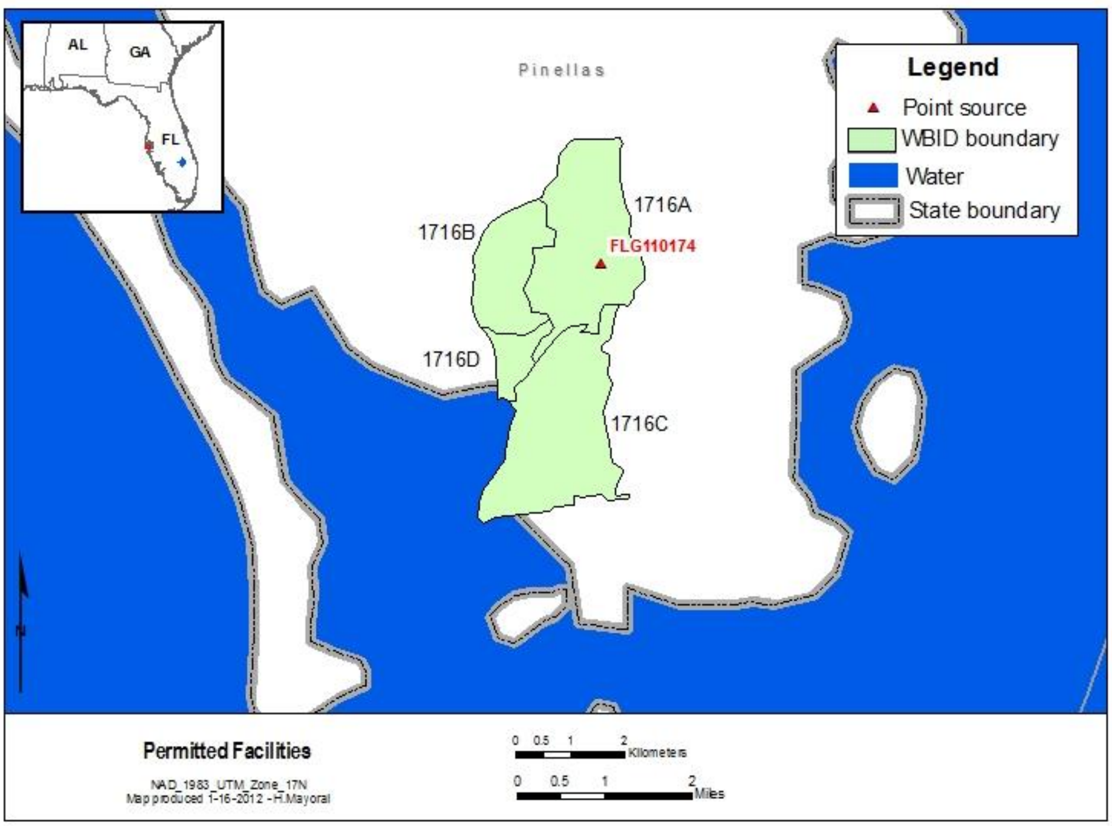

Figure 6.1 Permitted facilities in the impaired WBIDs in the Clam Bayou basin.

Table 6.1 Permitted Facilities by WBID.

WBID	Facility Number	Facility Name	Type
1716A	FLG110174	Florida Rock Industries Inc. St. Petersburg Plant	Commercial

6.1.2 Stormwater Permitted Facilities/MS4s

MS4s are point sources also regulated by the NPDES program. According to 40 CFR 122.26(b)(8), an MS4 is "a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

(i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law)...including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the Clean Water Act that discharges into waters of the United States;

(ii) Designed or used for collecting or conveying storm water;

(iii) Which is not a combined sewer; and

(iv) Which is not part of a Publicly Owned Treatment Works."

MS4s may discharge nutrients and other pollutants to waterbodies in response to storm events. In 1990, USEPA developed rules establishing Phase I of the NPDES stormwater program, designed to prevent harmful pollutants from being washed by stormwater runoff into MS4s (or from being dumped directly into the MS4) and then discharged from the MS4 into local waterbodies. Phase I of the program required operators of "medium" and "large" MS4s (those generally serving populations of 100,000 or greater) to implement a stormwater management program as a means to control polluted discharges from MS4s. Approved stormwater management programs for medium and large MS4s are required to address a variety of water quality related issues including roadway runoff management, municipal owned operations, hazardous waste treatment, etc.

Phase II of the rule extends coverage of the NPDES stormwater program to certain "small" MS4s. Small MS4s are defined as any MS4 that is not a medium or large MS4 covered by Phase I of the NPDES stormwater program. Only a select subset of small MS4s, referred to as "regulated small MS4s", requires an NPDES stormwater permit. Regulated small MS4s are defined as all small MS4s located in "urbanized areas" as defined by the Bureau of the Census, and those small MS4s located outside of "urbanized areas" that are designated by NPDES permitting authorities.

In October 2000, USEPA authorized FDEP to implement the NPDES stormwater program in all areas of Florida except Indian tribal lands. FDEP's authority to administer the NPDES program is set forth in Section 403.0885, Florida Statutes (FS). The three major components of NPDES stormwater regulations are:

- MS4 permits that are issued to entities that own and operate master stormwater systems, primarily local governments. Permittees are required to implement comprehensive stormwater management programs designed to reduce the discharge of pollutants from the MS4 to the maximum extent practicable.
- Stormwater associated with industrial activities, which is regulated primarily by a multisector general permit that covers various types of industrial facilities. Regulated industrial facilities must obtain NPDES stormwater permit coverage and implement appropriate pollution prevention techniques to reduce contamination of stormwater.
- Construction activity general permits for projects that ultimately disturb one or more acres of land and which require the implementation of stormwater pollution prevention plans to provide for erosion and sediment control during construction.

Stormwater discharges conveyed through the storm sewer system covered by the permit are subject to the WLA of the TMDL. Any newly designated MS4s will also be required to achieve the percent reduction allocation presented in this TMDL. Phase I and Phase II MS4 permits by WBID are listed on Table 6.2.

Table 6.2 MS4 Permits by WBID.

WBID	Segment Name	Phase	Facility Number	Permittee	Co-Permittee
1716A	34th Street Basin	I C	FLS000005	Pinellas County	Florida Department of Transportation
		I	FLS000007	City of St. Petersburg	
1716B	Clam Bayou Drain	I C	FLS000005	Pinellas County	Florida Department of Transportation
		I	FLS000007	City of St. Petersburg	
1716C	Clam Bayou (E Drainage)	I C	FLS000005	Pinellas County	City of Gulfport Florida Department of Transportation
		I	FLS000007	City of St. Petersburg	
1716D	Clam Bayou Drain (Tidal)	I C	FLS000005	Pinellas County	City of Gulfport Florida Department of Transportation
		I	FLS000007	City of St. Petersburg	

6.2 Nonpoint Sources

Nonpoint sources of pollution are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. For nutrients, these sources include runoff of agricultural fields, golf courses, and lawns, septic tanks, and residential developments outside of MS4 areas. Nonpoint source pollution generally involves a buildup of pollutants on the land surface that wash off during rain events and as such, represent contributions from diffuse sources, rather than from a defined outlet. Potential nonpoint sources are commonly identified, and their loads estimated, based on land cover data. Most methods calculate nonpoint source loadings as the product of the water quality concentration and runoff water volume associated with certain land use practices. The mean concentration of pollutants in the runoff from a storm event is known as the event mean concentration. Figure 3.1 provides a map of the land use in the WBIDs. Table 3.1 lists the land use distribution for each of the WBIDs.

The following sections are organized by land use. Each section provides a description of the land use, the typical sources of nutrient loading (if applicable), and typical total nitrogen and total phosphorus event mean concentrations.

6.2.1 Urban Areas

Urban areas include land uses such as residential, industrial, extractive and commercial. Land uses in this category typically have somewhat high total nitrogen event mean concentrations and average total phosphorus event mean concentrations. Nutrient loading from MS4 and non-MS4 urban areas is attributable to multiple sources including stormwater runoff, leaks and overflows from sanitary sewer systems, illicit discharges of sanitary waste, runoff from improper disposal of waste materials, leaking septic systems, and domestic animals.

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as outlined in Chapter 403 FS, was established as a technology-based program that relies upon the implementation of Best Management Practices (BMPs) that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, FAC.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water." [FAC 62-40-.432(2)(c)]

Nonstructural and structural BMPs are an integral part of the State's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of nonpoint source pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimization of impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

Urban, residential, and commercial developments are likely the most significant nonpoint sources of nutrients and oxygen-demanding substances because a large percentage of the land use developed. Developed land use of varying intensities accounts for over 95 percent of land use in WBIDs 1716A, 1716B, and 1716D, and 84 percent in WBID 1716C. Nearly all of the developed land uses in the WBIDs are classified as high intensity development.

Onsite Sewage Treatment and Disposal Systems (Septic Tanks)

As stated above leaking septic tanks or onsite sewage treatment and disposal systems (OSTDs) can contribute to nutrient loading in urban areas. Water from OSTDs is typically released to the ground through on-site, subsurface drain fields or boreholes that allow the water from the tank to percolate (usually into the surficial aquifers) and either transpire to the atmosphere through surface vegetation or add to the flow of shallow ground water. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD receives natural biological treatment in the soil and is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrients, pathogens, and other pollutants to both ground water and surface water.

The State of Florida Department of Health publishes data on new septic tank installations and the number of septic tank repair permits issued for each county in Florida. Table 6.3 summarizes the cumulative number of septic systems installed in Pinellas County since the 1970 census and the total number of repair permits issued for the ten years between 1999-2000 and 2009-2010 (FDOH 2009). The data do not reflect septic tanks removed from service. Leaking septic systems could be a relevant source of organic and nutrient loading in the watershed.

Table 6.3 County estimates of Septic Tanks and Repair Permits.

County	Number of Septic Tanks (1970-2008)	Number of Repair Permits Issued (2000-2010)
Pinellas	23,869	3,015

Note: Source: http://www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm

6.2.2 Pastures

Pastures include cropland and improved and unimproved pasturelands, such as non-tilled grasses woodland pastures, feeding operations, nurseries and vineyards; as well as specialty farms. Agricultural activities, including runoff of fertilizers or animal wastes from pasture and cropland and direct animal access to streams, can generate nutrient loading to streams. The highest total nitrogen and total phosphorus event mean concentrations are associated with agricultural land uses. None of the contributing watersheds to the WBIDs in Clam Bayou contain pasture land uses.

6.2.3 Clear cut/Sparse

The clear cut/sparse land use classification includes recent clear cuts, areas of sparse vegetation or herbaceous dry prairie, shrub and brushland, other early successional areas, and mixed rangeland. Event mean concentrations for clear cut/sparse are about average for total nitrogen and low for total phosphorus. None of the contributing watersheds to the WBIDs in Clam Bayou contain clear cut or sparse land uses.

6.2.4 Forests

Upland forests include flatwoods, oak, various types of hardwoods, conifers and tree plantations. Wildlife, located within forested areas, deposit their feces onto land surfaces where it can be transported to nearby streams during storm events. Generally, the pollutant load from wildlife is assumed to represent background concentrations. Event mean concentrations for upland forests are low for both total nitrogen and total phosphorus. WBID 1716A, 1716B, and 1716D do not have any forested land uses in their contributing watersheds. Approximately 8 percent of the contributing land use to WBID 1716C is classified as forested.

6.2.5 Water and Wetlands

Water and Wetlands often have very low nutrient loadings, although decaying organic matter in wetlands can contribute to high organic nutrient concentrations. WBIDs 1716A, 1716C, and 1716D all have small areas classified as wetlands. All four WBIDs have open water land uses in their contributing watersheds.

6.2.6 Quarries/Strip mines

Land use classification includes quarries, strip mines, exposed rock and soil, fill areas, reclaimed lands, and holding ponds. Event mean concentrations for some barren lands tend to be higher in total nitrogen. None of the contributing watersheds to the WBIDs in Clam Bayou contain quarries or strip mine land uses.

7.0 ANALYTICAL APPROACH

In the development of a TMDL there needs to be a method for relating current loadings to the observed water quality problem. This relationship could be: statistical (regression for a cause and effect relationship), empirical (based on observations not necessarily from the waterbody in question) or mechanistic (physically and/or stochastically based) that inherently relate cause and effect using physical and biological relationships.

Mechanistic models were used in the development of the Clam Bayou TMDL to relate the physical and biological relationships. A dynamic watershed model was used to predict the quantity of water and pollutants associated with runoff from rain events. The watershed model was linked to a hydrodynamic model that simulated tidal influences in the river. Both models were linked to a water quality simulation model that integrated the loadings and flow from the watershed model with flow from the hydrodynamic model to predict the water quality in the receiving waterbodies.

The period of simulation that was considered in the development of this TMDL is January 1, 2002 to December 31, 2009. The models were used to predict time series for BOD, TN, TP, and DO. The models were calibrated to current conditions and were then used to predict improvements in water quality as function of reductions in loadings.

7.1 Mechanistic Models

7.1.1 Loading Simulation Program C++ (LSPC)

LSPC is the Loading Simulation Program in C++, a watershed modeling system that includes streamlined Hydrologic Simulation Program Fortran (HSPF) algorithms for simulating hydrology, sediment, and general water quality overland as well as a simplified stream fate and transport model. LSPC is derived from the Mining Data Analysis System (MDAS), which was originally developed by USEPA Region 3 (under contract with Tetra Tech) and has been widely used for TMDLs. In 2003, the USEPA Region 4 contracted with Tetra Tech to refine, streamline, and produce user documentation for the model for public distribution. LSPC was developed to serve as the primary watershed model for the USEPA TMDL Modeling Toolbox. LSPC was used to simulate runoff (flow, biological oxygen demand, total nitrogen, total phosphorus and dissolved oxygen) from the land surface using a daily timestep for current and natural conditions. LSPC provided tributary flows and temperature to the EFDC estuary models and tributary water quality concentrations to WASP7 estuary models.

An LSPC model was utilized to estimate the nutrient loads within and discharged from the Clam Bayou watershed. The LSPC model utilized data inputs from the larger Crystal Watershed model developed for the Florida Numeric Nutrient Criteria (USEPA 2012a and USEPA 2012b).

In order to evaluate the contributing sources to a waterbody and to represent the spatial variability of these sources within the watershed model, the contributing drainage area was represented by a series of sub-watersheds for each of the models. The sub-watersheds for the Crystal Watershed model were developed using the 12-digit hydrologic unit code (HUC12) watershed data layer and the Geological Survey (USGS) National Hydrograph Dataset (NHD). The Crystal Watershed model was then further redefined into smaller subwatersheds for the Clam Bayou model using the NHD catchments and USGS National Elevation Dataset Digital Elevation Model (DEM) (Figure 7.1).

The LSPC model has a representative reach defined for each sub-watershed, and the main channel stem within each sub-watershed was used as the representative reach. The characteristics for each reach include the length and slope of the reach, the channel geometry and the connectivity between the sub-watersheds. Length and slope data for each reach was obtained using the USGS DEM and NHD data.

The attributes supplied for each reach were used to develop a function table (FTABLE) that describes the hydrology of the stream reach by defining the functional relationship between water depth, surface area, water volume, and outflow in the segment. The assumption of a fixed depth, area, volume, outflow relationship rules out cases where the flow reverses direction or where one reach influences another upstream of it in a time-dependent way. LSPC does not model the tidal flow in the low-lying estuaries, and therefore the Crystal Watershed model was calibrated to non-tidally influenced USGS gages, and the hydrodynamic parameterization from the Crystal Watershed was used in the Clam Bayou model. The Clam Bayou Watershed model was linked to the EFDC and WASP models to simulate the areas of the estuary that were tidally influenced.

The watershed model uses land use data as the basis for representing hydrology and nonpoint source loadings. The FDEP Level III Florida Land Use, specifically the Southwest Florida Water Management District (SWFWMD) 2006 dataset, was used to determine the land use representation. The National Landuse Coverage Dataset (NLCD) was used to develop the impervious land use representations.

The SWFWMD coverage utilized a variety of land use classes which were grouped and re-classified into 18 land use categories: beaches/dune/mud, open water, utility swaths, developed open space, developed low intensity, developed medium intensity, developed high intensity, clear-cut/sparse, quarries/strip mines, deciduous forest, evergreen forest, mixed forest, golf courses, pasture, row crop, forested wetland, non-forested wetland (salt/brackish), and non-forested wetland (freshwater). The LSPC model requires division of land uses in each sub-watershed into separate pervious and impervious land units. The 2006 NLCD 2006 percent impervious coverage was used to determine the percent impervious area associated with each land use category. Any impervious areas associated with utility swaths, developed open space, and developed low intensity, were grouped together and placed into a new land use category named low intensity development impervious. Impervious areas associated with medium intensity development and high intensity development were kept separate and placed into two new categories for medium intensity development impervious and high intensity development impervious, respectively. Finally, any impervious area not already accounted for in the three developed impervious categories, were grouped together into a fourth new category for all remaining impervious land use.

Soil data was obtained from the Soil Survey Geographic Database (SSURGO). The database was produced and distributed by the Natural Resources Conservation Service (NRCS) - National Cartography and Geospatial Center (NCGC). The SSURGO data was used to determine the total area that each hydrologic soil group covered within each sub-watershed. The sub-watersheds were represented by the hydrologic soil group that had the highest percentage of coverage within the boundaries of the sub-watershed.

In the watershed model, nonpoint source loadings and hydrological conditions are dependent on weather conditions. Hourly data from weather stations within the boundaries of, or in close proximity to, the sub-watersheds were applied to the watershed model. A weather data forcing file was generated in ASCII format (*.air) for each meteorological station used in the hydrological evaluations in LSPC. Each meteorological station file contained atmospheric data used in modeling the hydrological processes. These data included precipitation, air temperature, dew point temperature, wind speed, cloud cover, evaporation, and solar radiation. These data are used directly, or calculated from the observed data. The Clam Bayou Watershed model weather stations contained data through 2009.

No flow calibration stations were located in Clam Bayou or in the nearby vicinity. For this reason, the Clam Bayou model used the same parameters that were used in the larger Crystal Watershed (USEPA 2012b). The model parameters that were adjusted in the Crystal Watershed model consist of evapotranspiration, infiltration, upper and lower zone storage, groundwater storage, losses to the deep groundwater system, and Manning's n. The calibration of the LSPC watershed hydrology model involved comparing simulated streamflows to the USGS flow stations. The calibration of the hydrologic parameters was performed from January 1, 1997, through December 31, 2009.

The Clam Bayou watershed model also used the Crystal Watershed model water quality parameters. Water quality results were compared with measured data from IWR 44 in the Clam Bayou WBIDs. Water quality parameters, including nutrient accumulation and washoff, were adjusted for a better calibration. The water quality calibration for the Clam Bayou Model is shown in Figure 7.2 and Figure 7.11.

Figure 7.1 LSPC subwatershed boundaries and WASP model grid for Clam Bayou

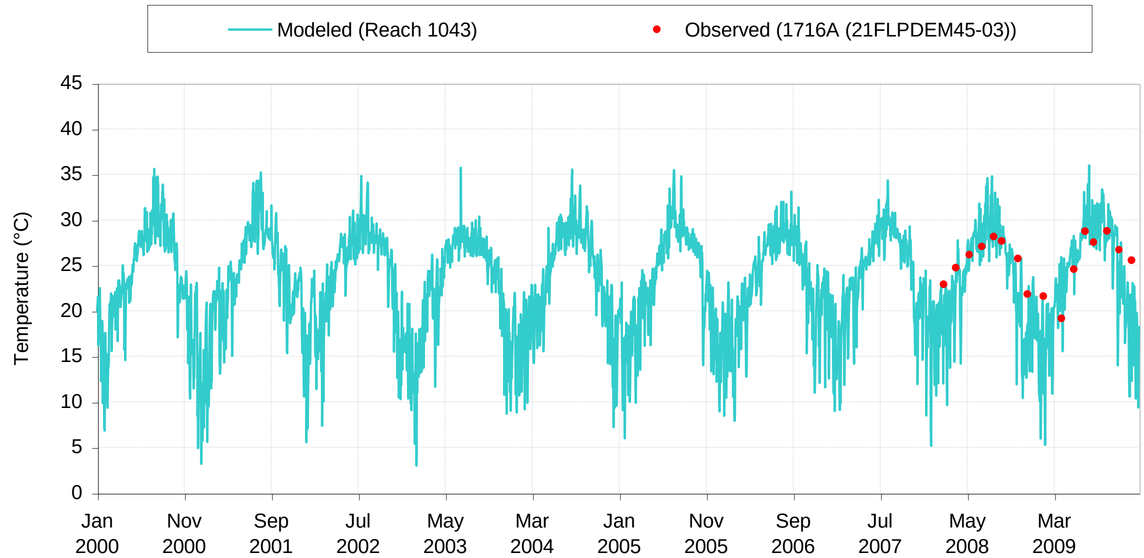

Figure 7.2 Modeled vs. Observed Temperature (°C) at 1716A (21FLPDEM45-03)

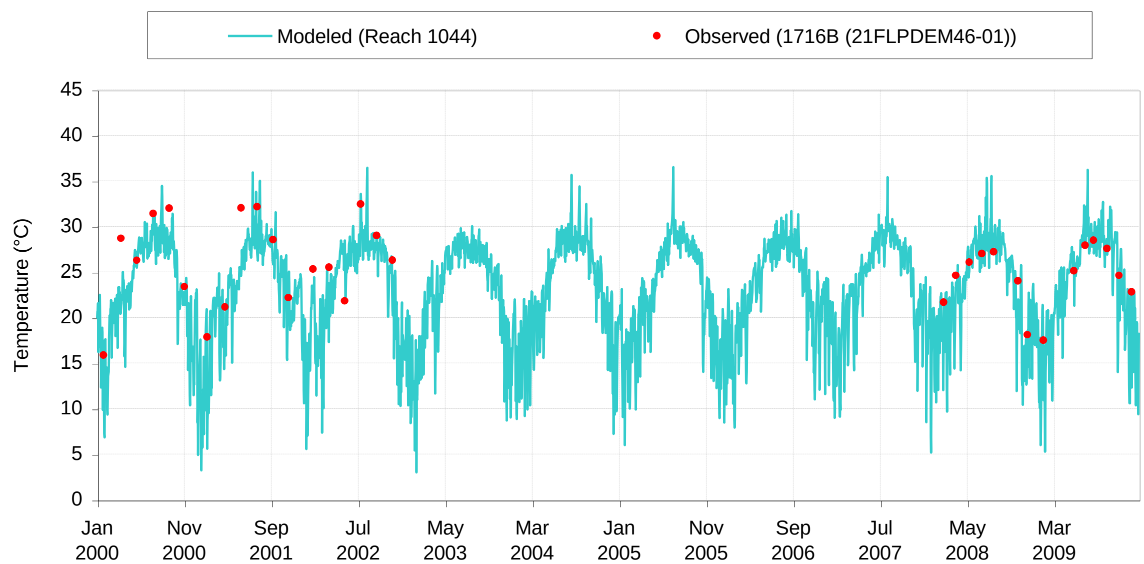

Figure 7.3 Modeled vs. Observed Temperature (°C) at 1716B (21FLPDEM46-01)

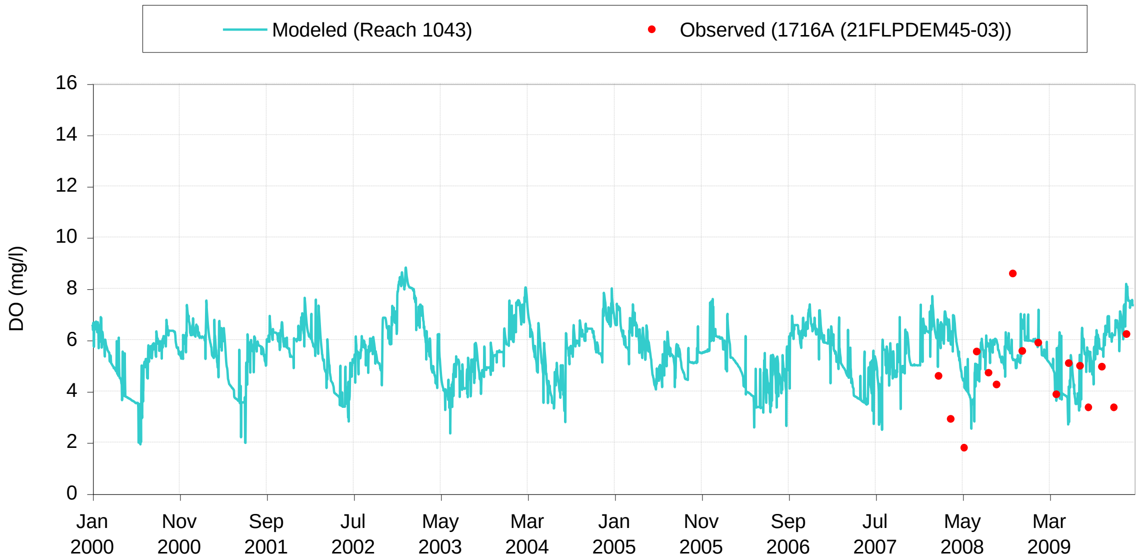

Figure 7.4 Modeled vs. Observed DO (mg/l) at 1716A (21FLPDEM45-03)

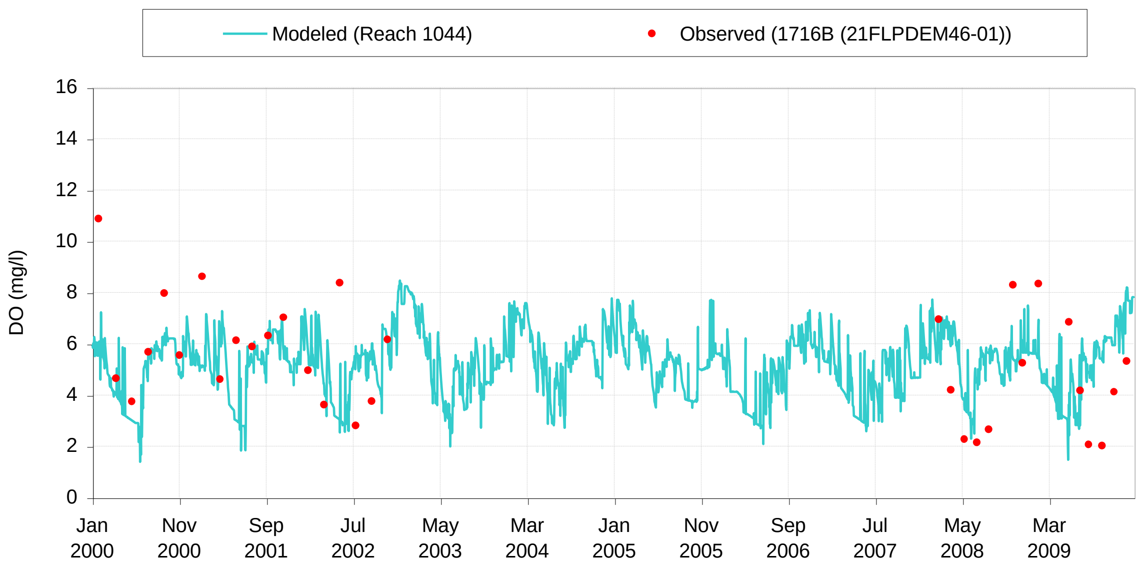

Figure 7.5 Modeled vs. Observed DO (mg/l) at 1716B (21FLPDEM46-01)

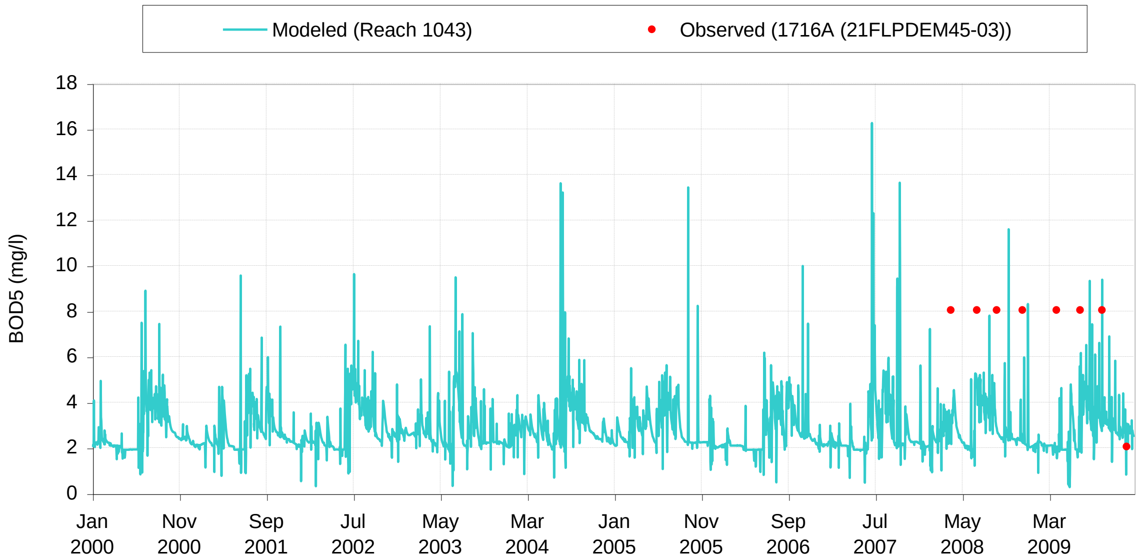

Figure 7.6 Modeled vs. Observed BOD5 (mg/l) at 1716A (21FLPDEM45-03)

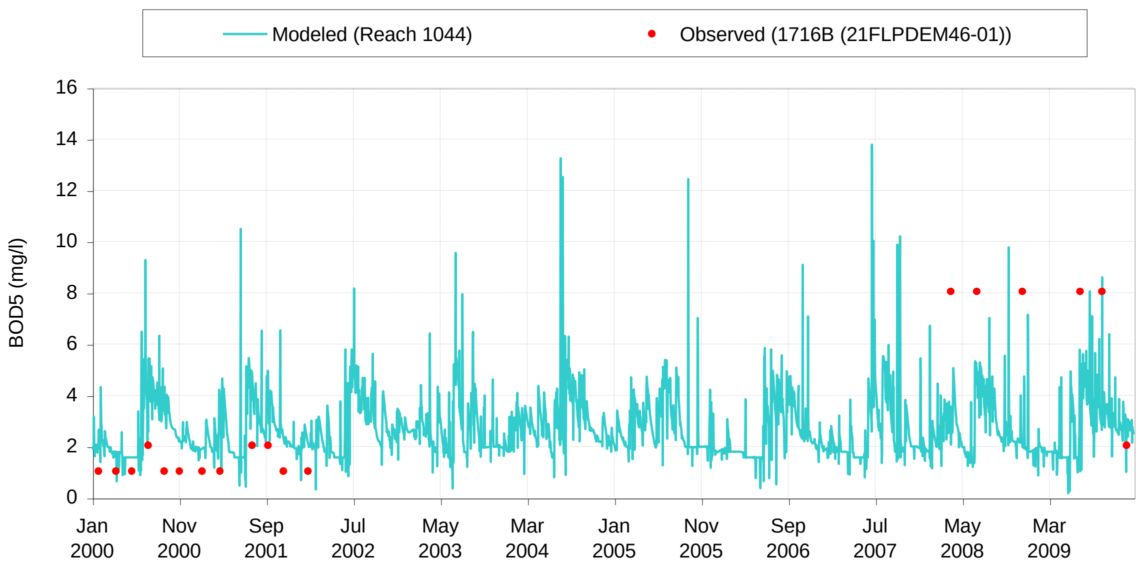

Figure 7.7 Modeled vs. Observed BOD5 (mg/l) at 1716B (21FLPDEM46-01)

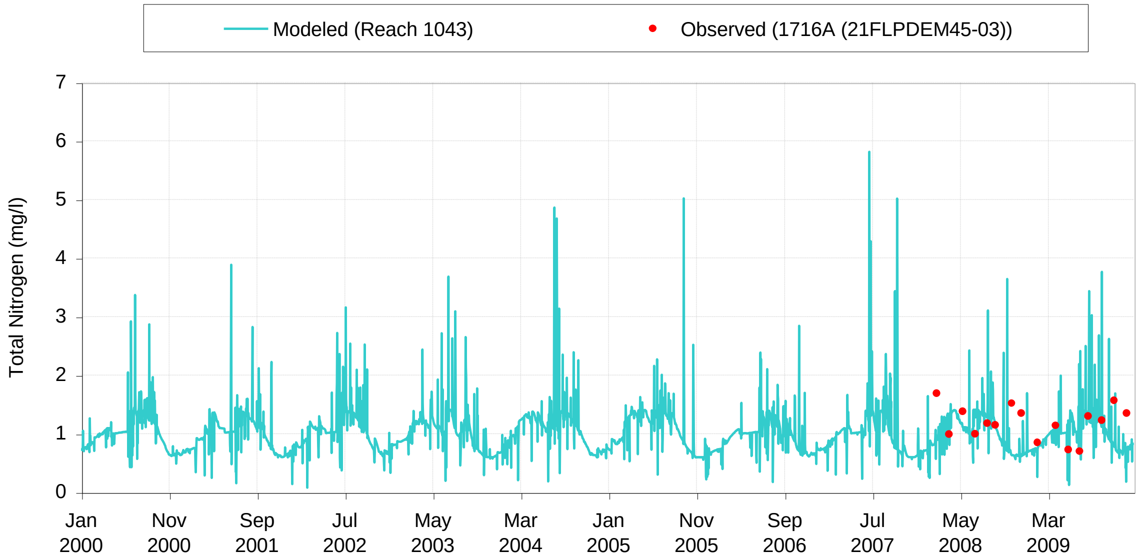

Figure 7.8 Modeled vs. Observed Total Nitrogen (mg/l) at 1716A (21FLPDEM45-03)

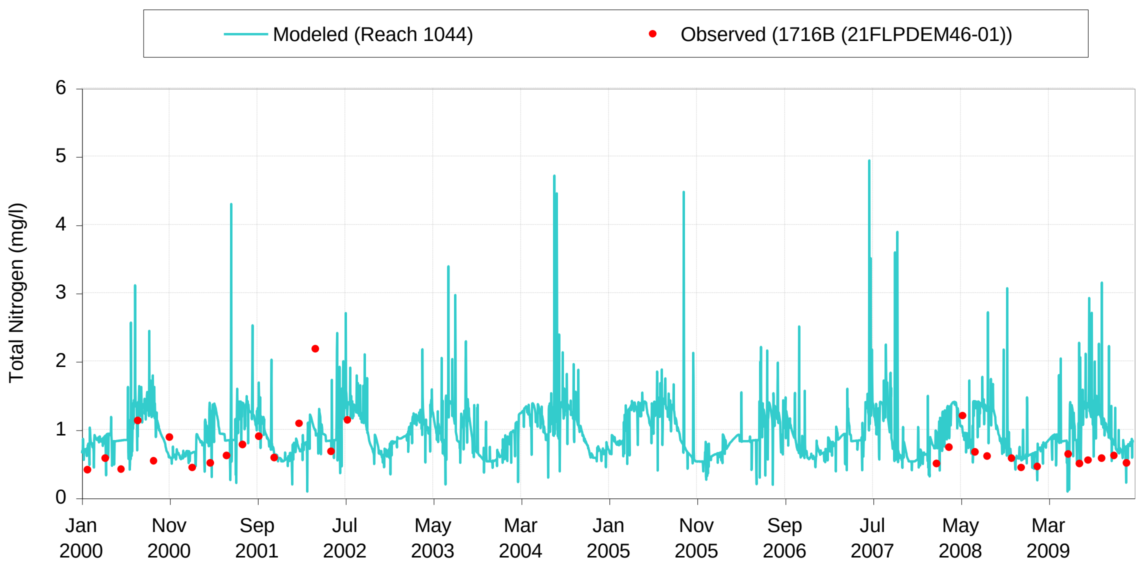

Figure 7.9 Modeled vs. Observed Total Nitrogen (mg/l) at 1716B (21FLPDEM46-01)

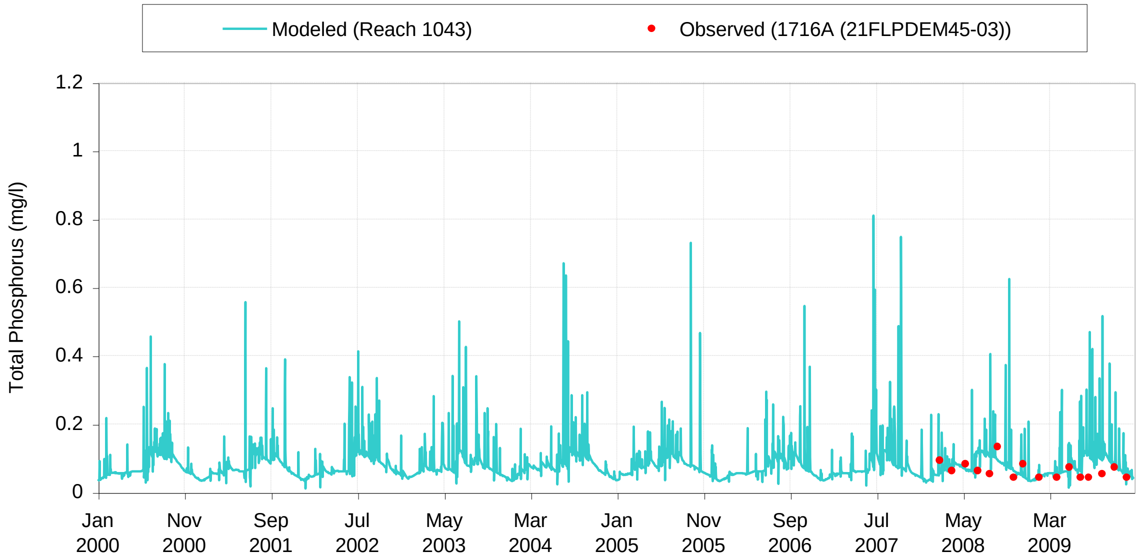

Figure 7.10 Modeled vs. Observed Total Phosphorus (mg/l) at 1716A (21FLPDEM45-03)

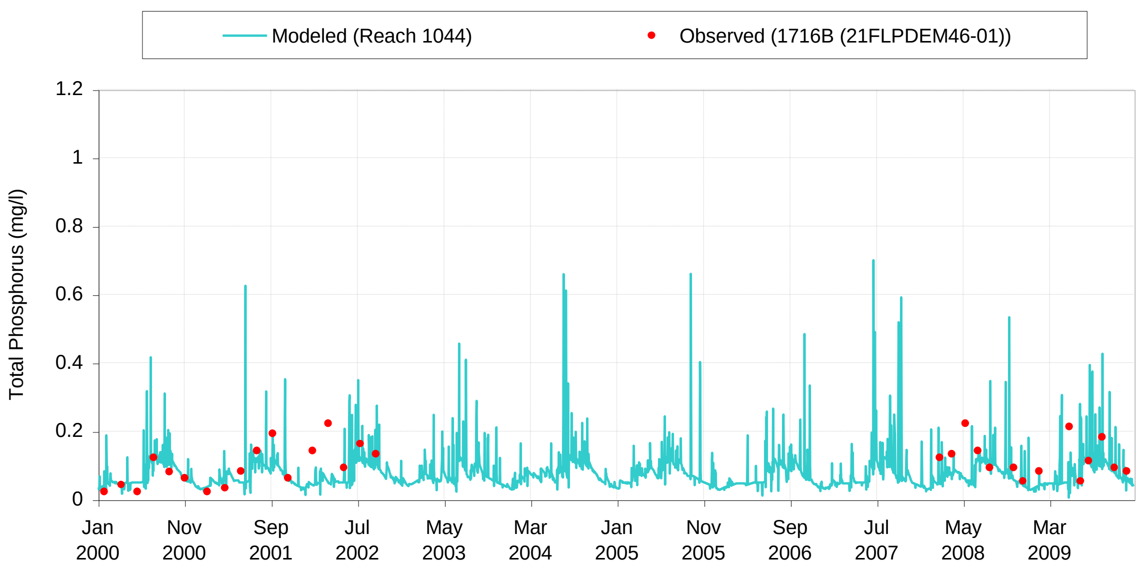

Figure 7.11 Modeled vs. Observed Total Phosphorus (mg/l) at 1716B (21FLPDEM46-01)

7.1.2 Environmental Fluids Dynamic Code (EFDC)

The EFDC model is a part of the USEPA TMDL Modeling Toolbox due to its application in many TMDL-type projects. As such, the code has been peer reviewed and tested and has been freely distributed and supported by Tetra Tech. EFDC was developed by Dr. John Hamrick (Hamrick 1992) and is currently supported by Tetra Tech for USEPA Office of Research and Development (ORD), USEPA Region 4, and USEPA Headquarters. The models, tools, and databases in the TMDL Modeling Toolbox are continually updated and upgraded through TMDL development in Region 4. EFDC is a multifunctional, surface-water modeling system, which includes hydrodynamic, sediment contaminant, and eutrophication components. The EFDC model is capable of 1, 2, and 3-dimensional spatial resolution. The model employs a curvilinear-orthogonal horizontal grid and a sigma or terrain following vertical grid.

The EFDC hydrodynamic model can run independently of a water quality model. The EFDC model simulates the hydrodynamic and constituent transport and then writes a hydrodynamic linkage file for a water quality model such as the Water Quality Analysis Program (WASP7) model. This model linkage, from EFDC hydrodynamics to WASP water quality, has been applied on many USEPA Region 4 projects in support of TMDLs and has been well tested (Wool et al. 2003).

The EFDC model was utilized to simulate three-dimensional circulation dynamics of hydrodynamic state variables (water surface elevation, salinity, and temperature) in the Clam Bayou estuary. An orthogonal, curvilinear grid system consisting of 3995 horizontal cells and 4 equally spaced vertical layers was developed for the Big Bend EFDC model. The grid was developed using Gulf of Mexico bathymetry data. The large grid was reduced in size and scale for the Clam Bayou EFDC model. Bathymetry was unavailable for the inland, tidally influenced streams, and channel slope from the USGS digital elevation model was used to estimate slope within the channel. To conduct numerical simulation of the hydrodynamics and water quality, the Clam Bayou grid was generated using the GEFDC and VOGG programs, which were used to compute cell widths and lengths (Figure 7.1).

The EFDC model predicts water surface elevation, salinity, and temperature, in response to a set of multiple factors: wind speed and direction, freshwater discharge, tidal water level fluctuation, rainfall, surface heat flux, and temperature and salinity associated with boundary fluxes. Hourly measurements of atmospheric pressure, dry and wet bulb atmospheric temperatures, rainfall rate, wind speed and direction, and fractional cloud cover were obtained from data collected at station two WBAN stations, Apalachicola and Clearwater, for 2002 through 2009. Solar short wave radiation was calculated using the CE-Qual-W2 method.

The Big Bend model used hourly water surface elevation time series data from the National Oceanic and Atmospheric Administration (NOAA) tidal stations to simulate tides at the open boundary. Observed temperature data at water quality stations were used to simulate the temperature at the open boundaries, and average salinity in the Gulf of Mexico was used to simulate salinity. The Big Bend Estuary was calibrated to measured NOAA tidal stations, and the Big Bend model was used to simulate the open boundary conditions in the Clam Bayou model. The upstream inland boundary grid cells received LSPC simulated watershed discharges and LSPC loadings. Freshwater enters the system via two paths, including direct reach inflows and overland runoff. LSPC model results were converted to EFDC model input files QSER.INP and TSER.INP.

7.1.3 Water Quality Analysis Simulation Program (WASP7)

The Water Quality Analysis Simulation Program Version 7.4.1 (WASP7) is an enhanced Windows version of the USEPA Water Quality Analysis Simulation Program (WASP) (Di Toro et al., 1983; Connolly and Winfield, 1984; Ambrose, R.B. et al., 1988), with upgrades to the user's interface and the model's capabilities. The major upgrades to WASP have been the addition of multiple BOD components, addition of sediment diagenesis routines, and addition of periphyton routines. The hydrodynamic file generated by EFDC is compatible with WASP7 and it transfers segment volumes, velocities, temperature and salinity, as well as flows between segments. The time step is set in WASP7 based on the hydrodynamic simulation.

WASP7 helps users interpret and predict water quality responses to natural phenomena and man-made pollution for various pollution management decisions. WASP7 is a dynamic compartment-modeling program for aquatic systems, including both the water column and the underlying benthos. The time-varying processes of advection, dispersion, point and diffuse mass loading and boundary exchange are represented in the basic program. Water quality processes are represented in special kinetic subroutines that are either chosen from a library or written by the user. WASP is structured to permit easy substitution of kinetic subroutines into the overall package to form problem-specific models. WASP7 comes with two such models, TOXI for toxicants and EUTRO for conventional water quality.

Because the LSPC model simulated TN, TP, and BOD and the WASP model simulated TN and its speciation, TP and its speciation, and CBOD, the water quality concentrations from LSPC were adjusted for WASP simulation prior to being input into the WASP model. TN was speciated into nitrate-nitrite (NOX), ammonia (NH4), and organic nitrogen (ON), and TP was speciated into orthophosphate (PO4) and organic phosphorus (OP). Water quality data in Clam Bayou was reviewed to determine the ratio of NOX, NH4, and ON in TN, and the ration of PO4 and OP in TP. The in-stream BOD loads from LSPC were converted to ultimate CBOD using an f-ratio of 1.5.

WASP7 utilized the same EFDC grid cell for the Clam Bayou model. Water quality loading from the LSPC model was used to simulate loads coming from rivers and streams into the estuary. Initially, default values of the rates and constants provided by WASP7 were used. Following initial set-up, calibration parameters from the Tampa Bay estuary model were used to populate rates and constants. The WASP7 model was run iteratively with updated rates and constants until model agree well with data in terms of temporal trends and magnitudes. The Clam Bayou model was calibrated to four water quality stations, and the results are shown in Figure 7.12 through Figure 7.30.

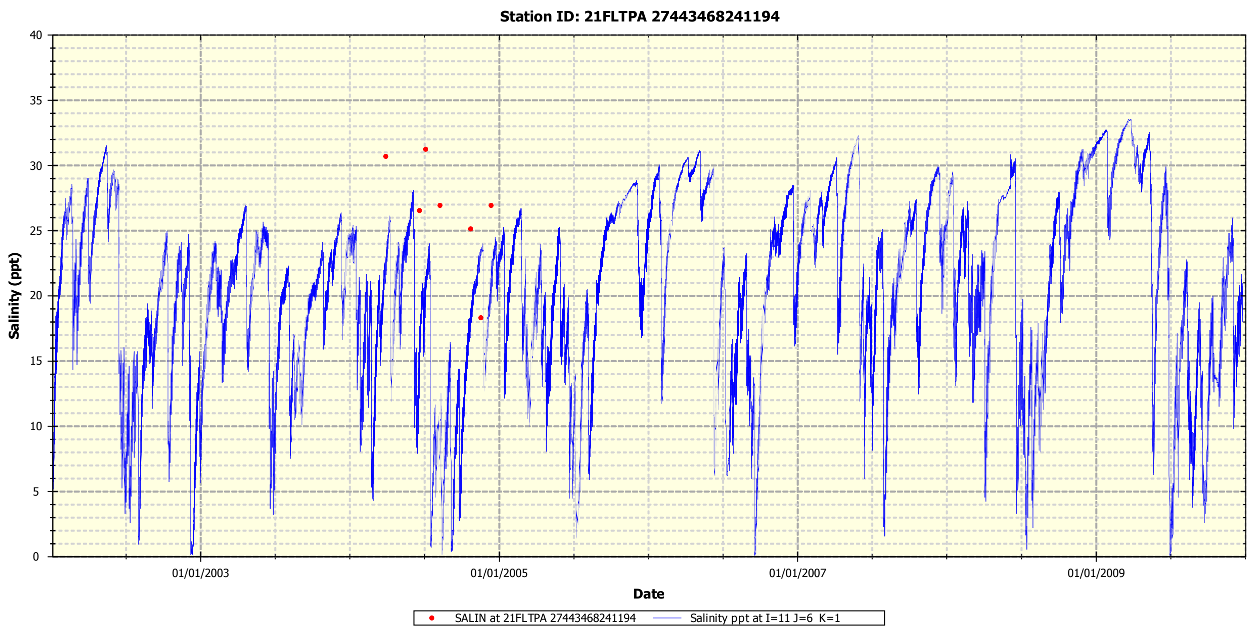

Figure 7.12 Simulated salinity verse measured salinity at station 21FLTPA27443468241194

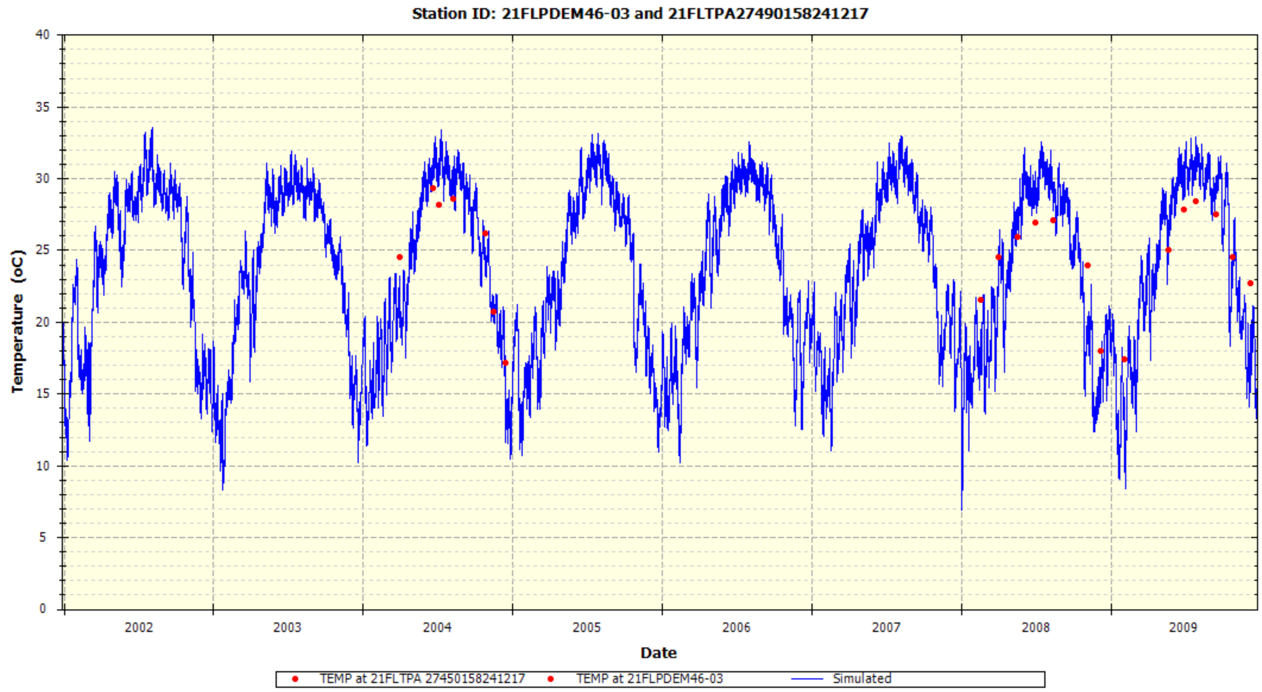

Figure 7.13 Simulated temperature (°C) verse measured temperature (°C) at stations 21FLPDEM46-03 and 21FLTPA27490158241217

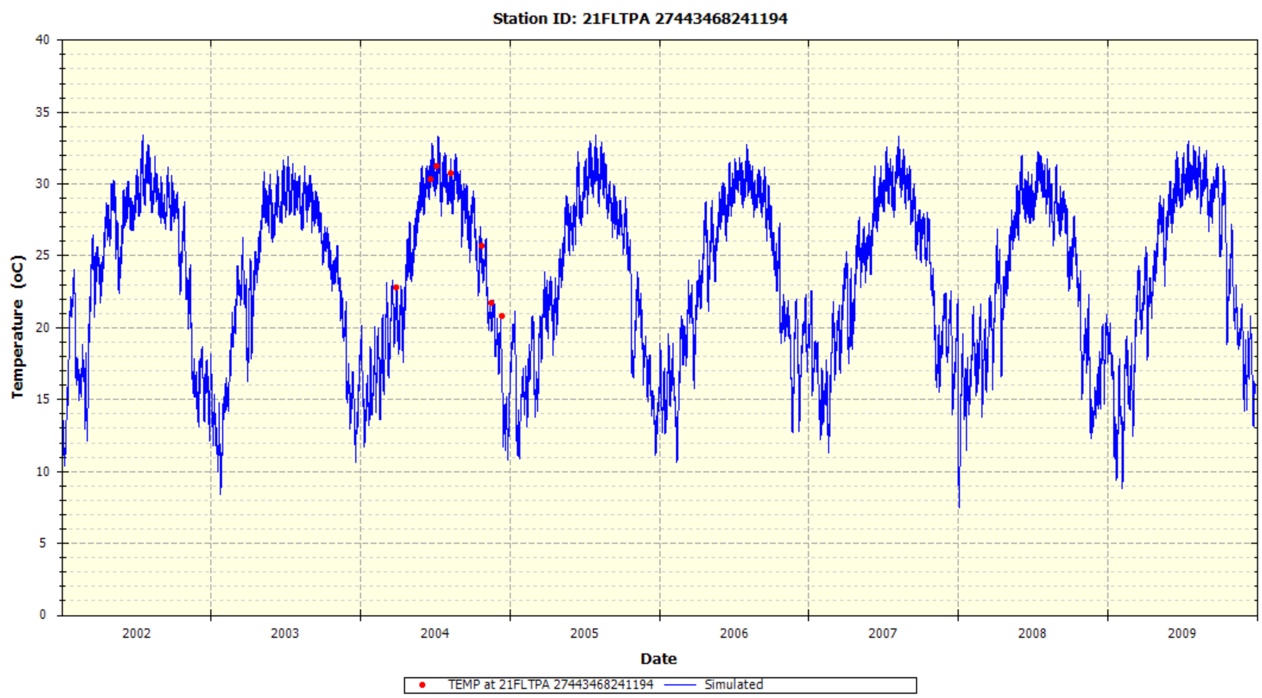

Figure 7.14 Simulated temperature (°C) verse measured temperature (°C) at station 21FLTPA27443468241194

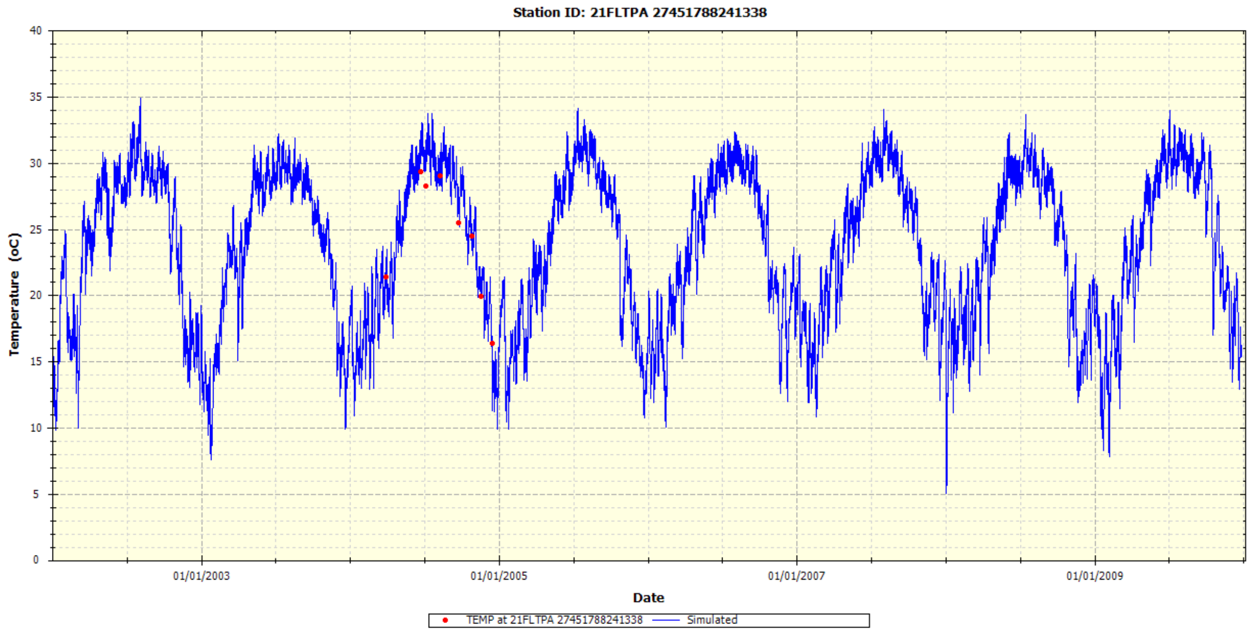

Figure 7.15 Simulated temperature (°C) verse measured temperature (°C) at station 21FLTPA27451788141338

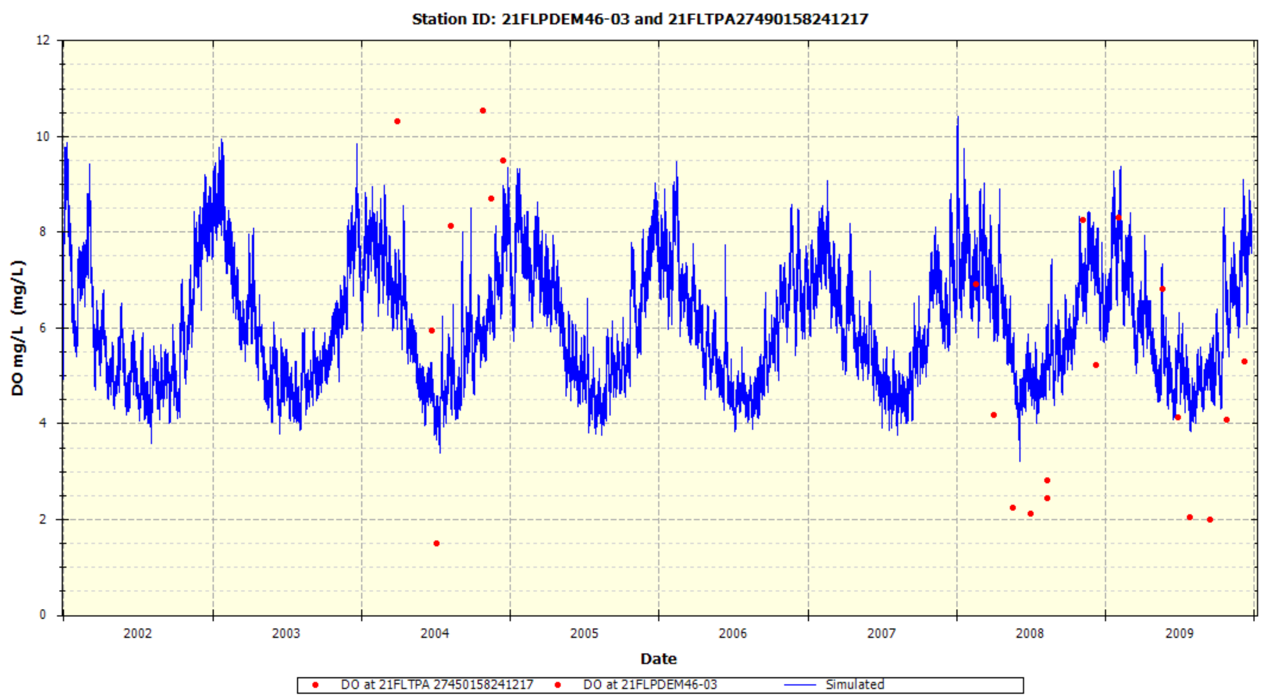

Figure 7.16 Simulated dissolved oxygen (mg/L) verse measured dissolved oxygen (mg/L) at stations 21FLPDEM46-03 and 21FLTPA27490158241217

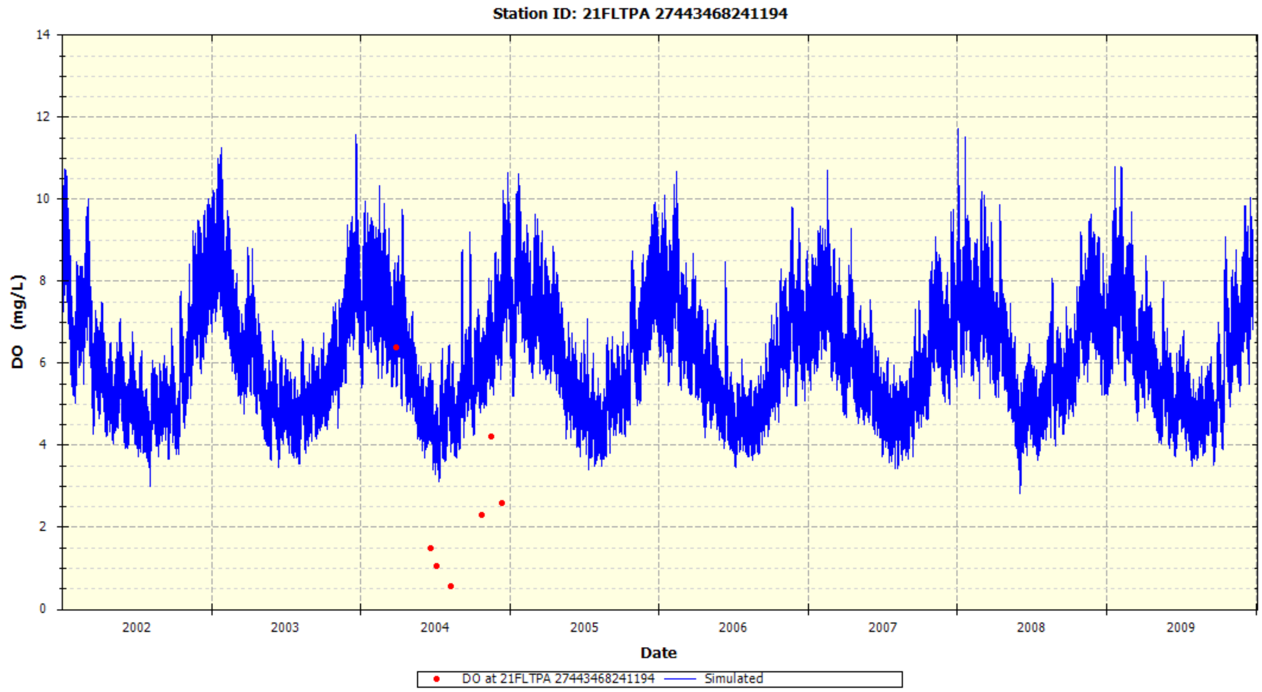

Figure 7.17 Simulated dissolved oxygen (mg/L) verse measured dissolved oxygen (mg/L) at station 21FLTPA27443468241194

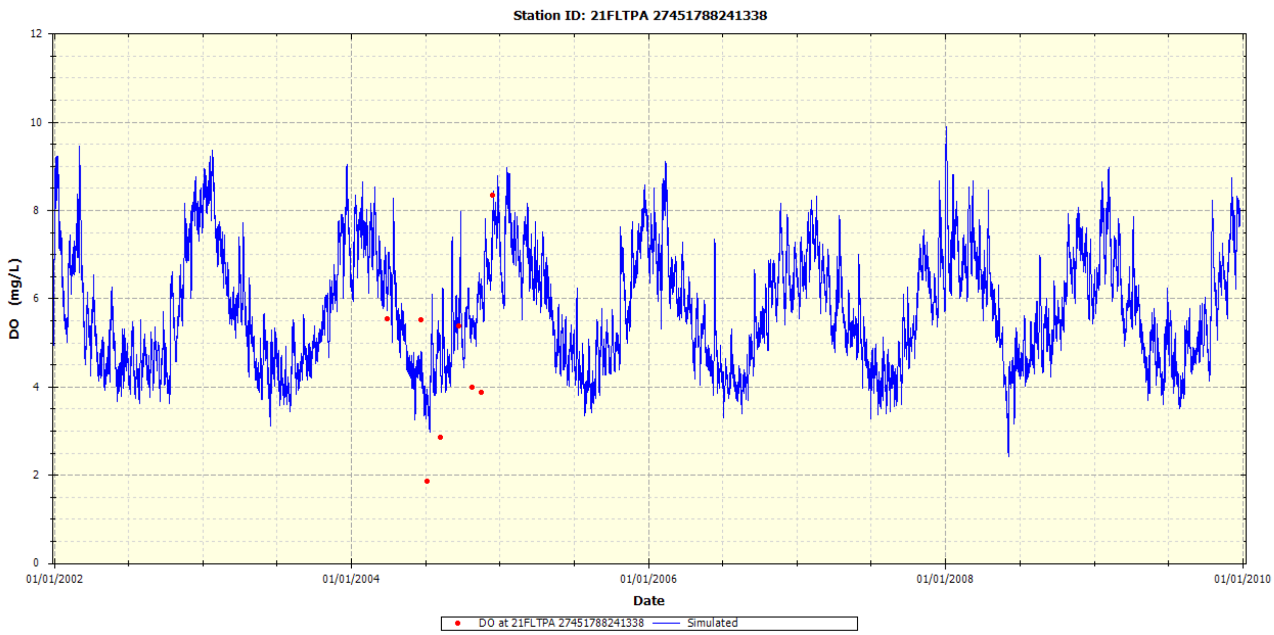

Figure 7.18 Simulated dissolved oxygen (mg/L) verse measured dissolved oxygen (mg/L) at station 21FLTPA27451788141338

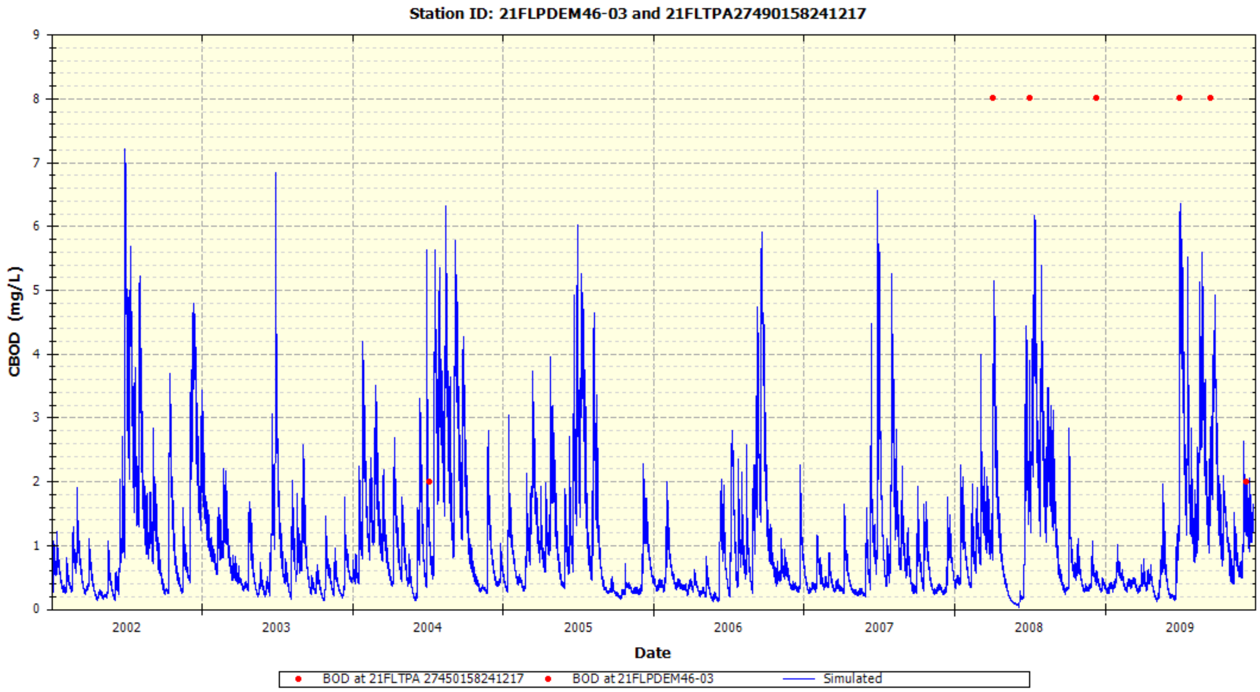

Figure 7.19 Simulated CBOD (mg/L) verse measured BOD5 (mg/L) at stations 21FLPDEM46-03 and 21FLTPA27490158241217

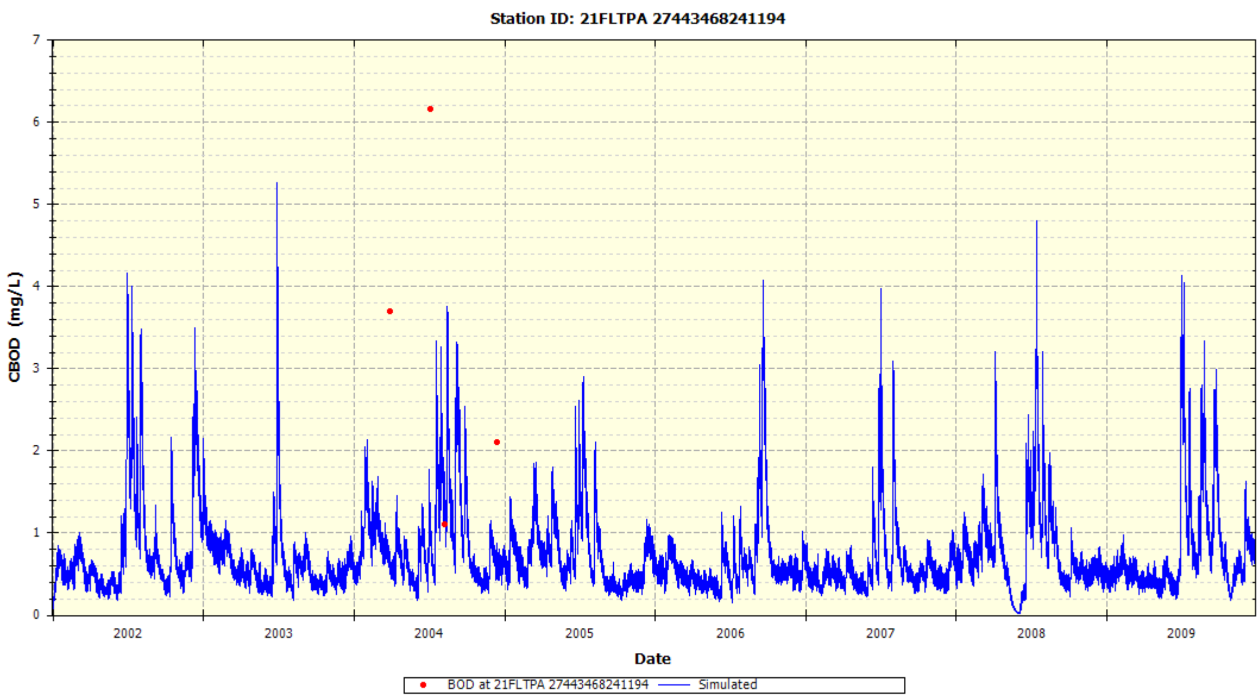

Figure 7.20 Simulated CBOD (mg/L) verse measured BOD5 (mg/L) at station 21FLTPA27443468241194

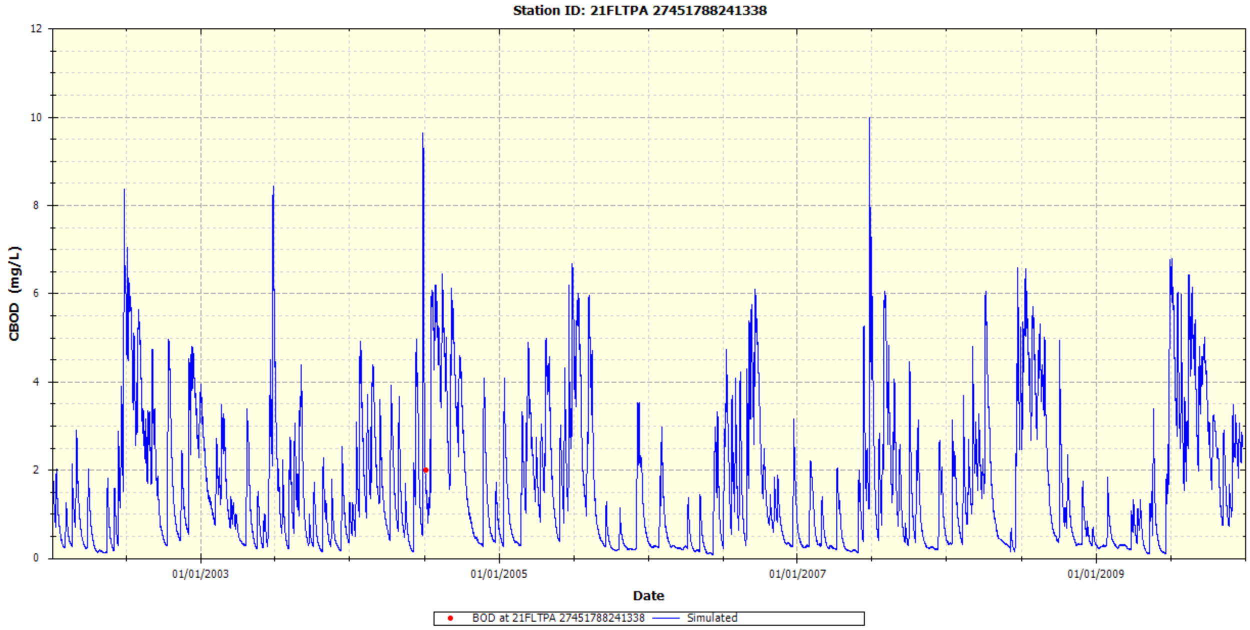

Figure 7.21 Simulated CBOD (mg/L) verse measured BOD5 (mg/L) at station 21FLTPA27451788141338

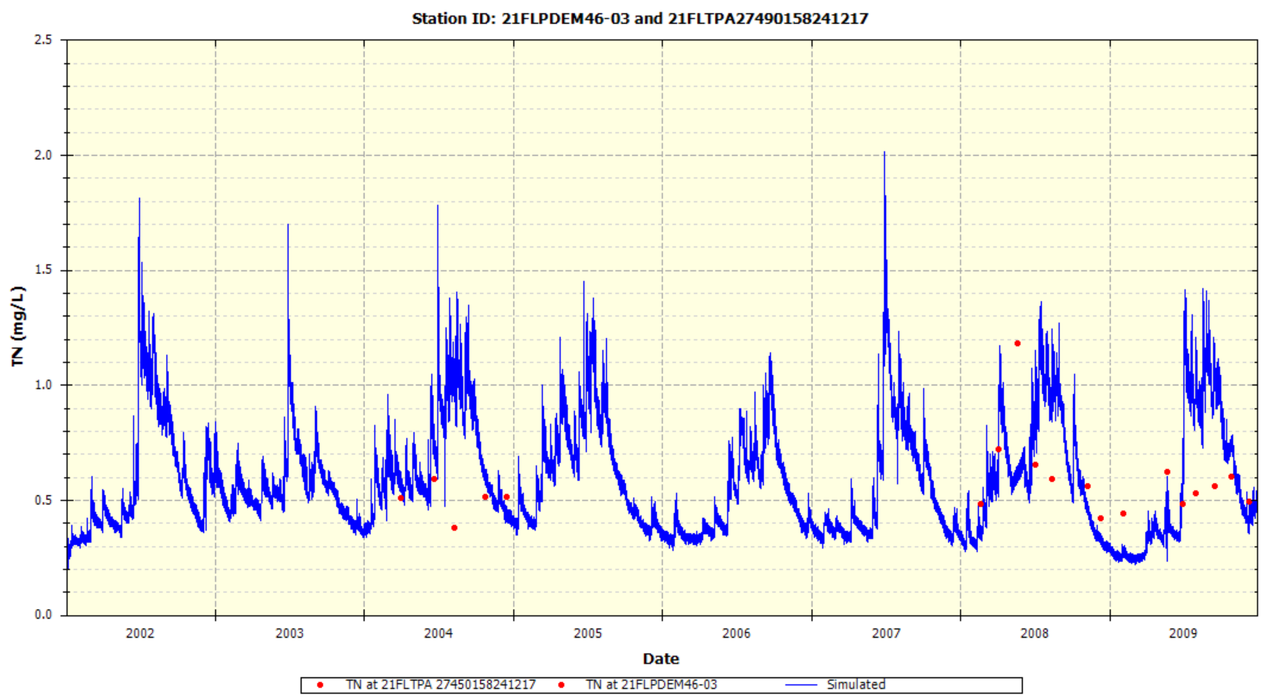

Figure 7.22 Simulated total nitrogen (mg/L) verse measured totel nitrogen (mg/L) at stations 21FLPDEM46-03 and 21FLTPA27490158241217

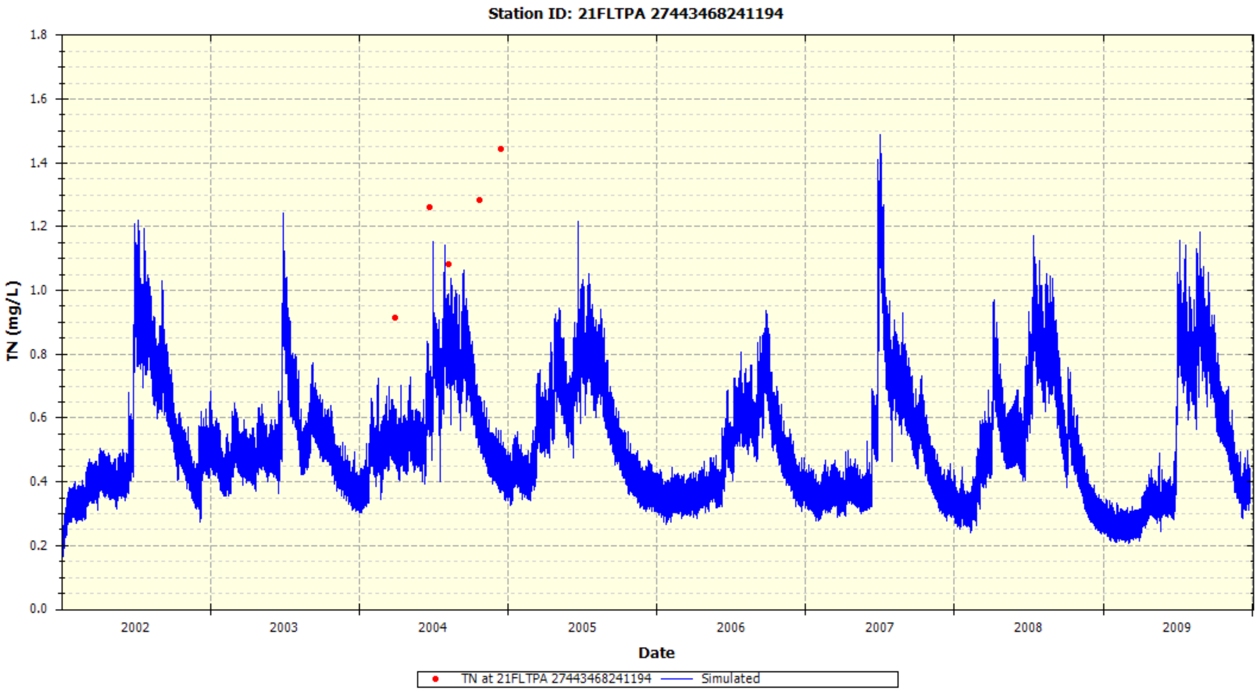

Figure 7.23 Simulated total nitrogen (mg/L) verse measured totel nitrogen (mg/L) at station 21FLTPA27443468241194

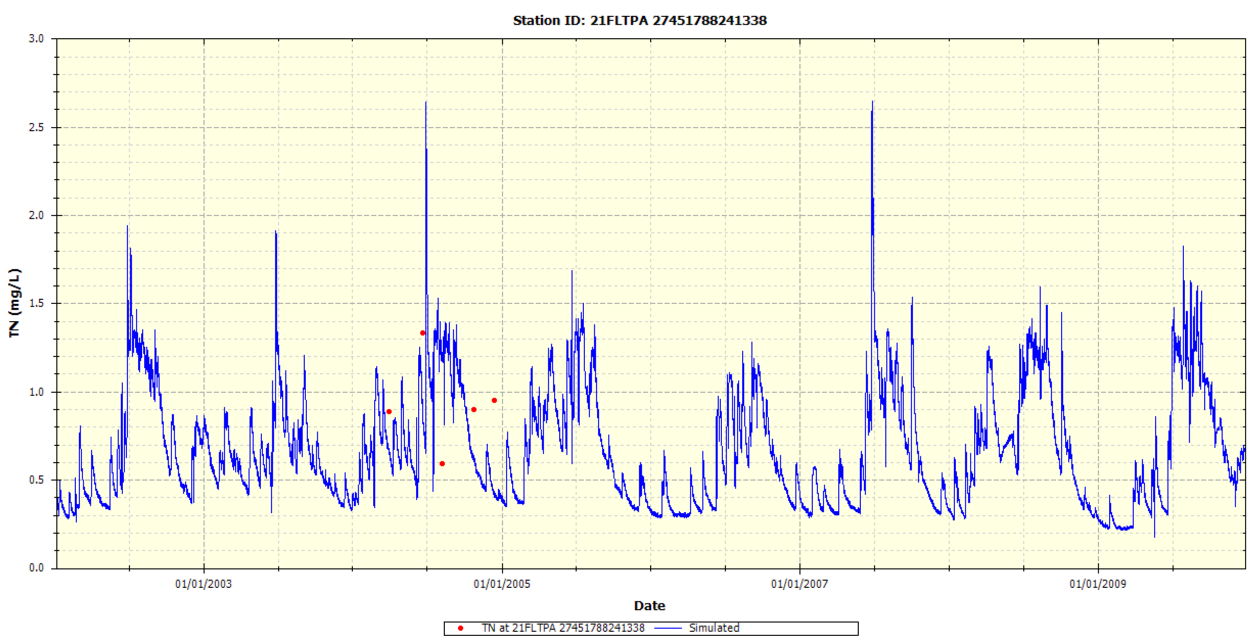

Figure 7.24 Simulated total nitrogen (mg/L) verse measured totel nitrogen (mg/L) at station 21FLTPA27451788141338

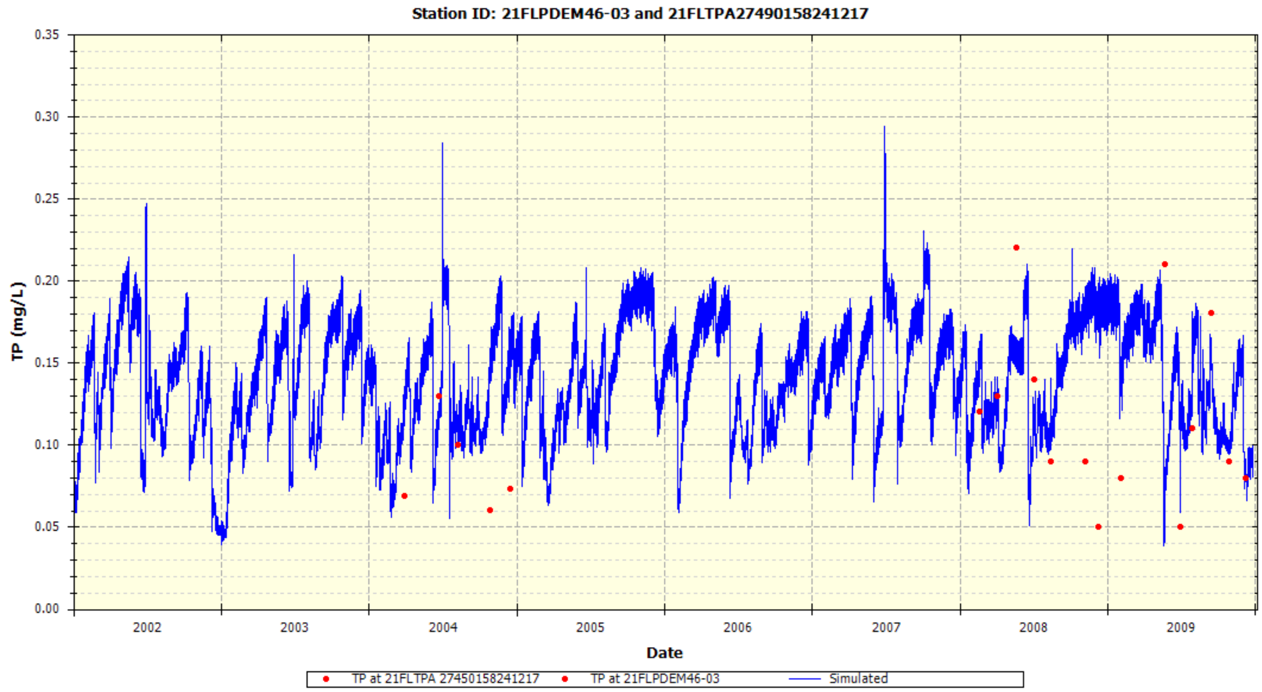

Figure 7.25 Simulated total phosphorus (mg/L) verse measured totel phosphorus (mg/L) at stations 21FLPDEM46-03 and 21FLTPA27490158241217

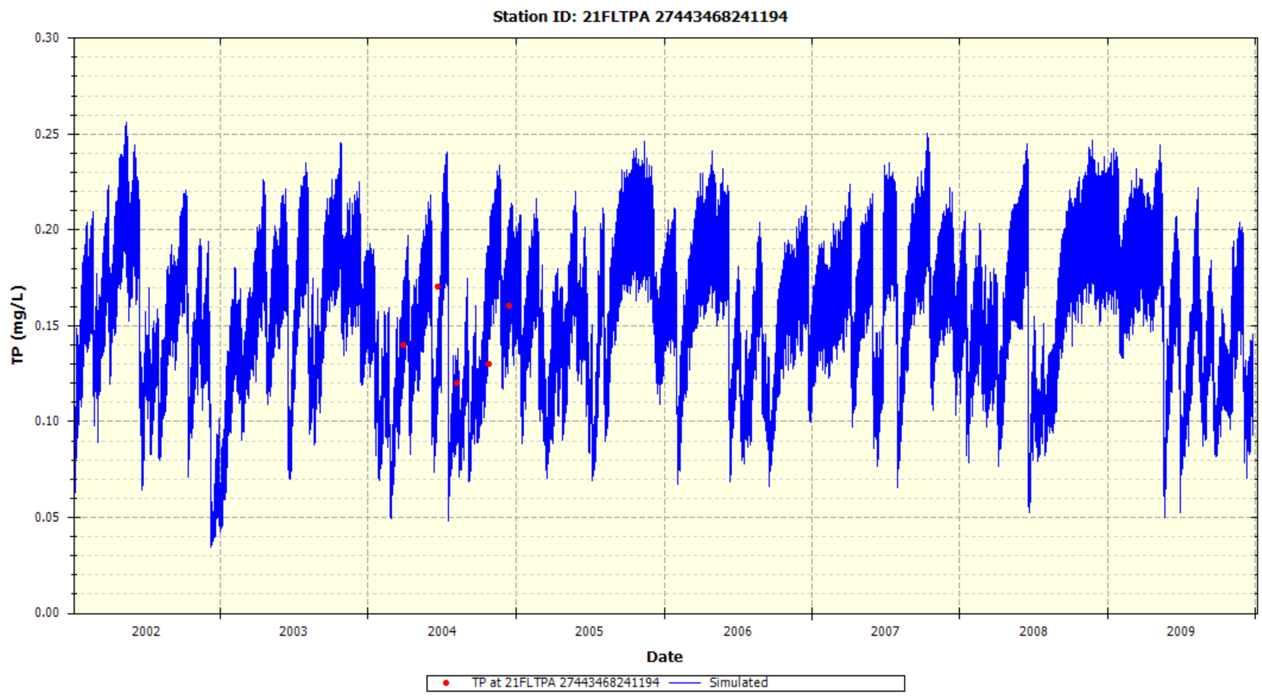

Figure 7.26 Simulated total phosphorus (mg/L) verse measured totel phosphorus (mg/L) at station 21FLTPA27443468241194

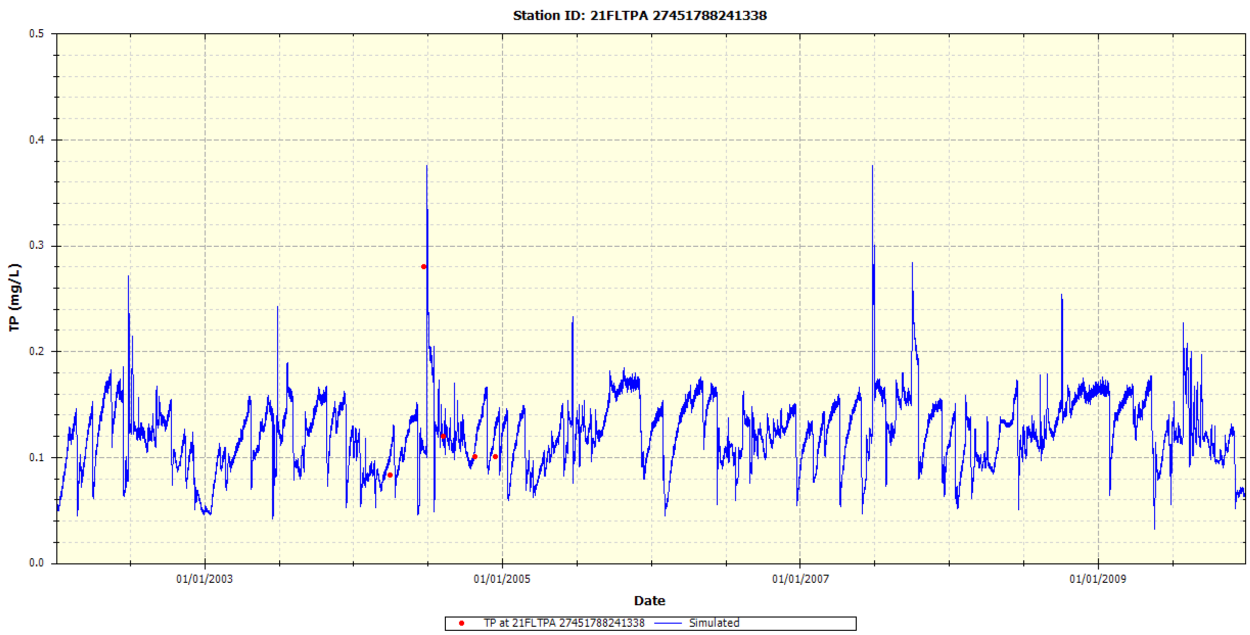

Figure 7.27 Simulated total phosphorus (mg/L) verse measured totel phosphorus (mg/L) at station 21FLTPA27451788141338

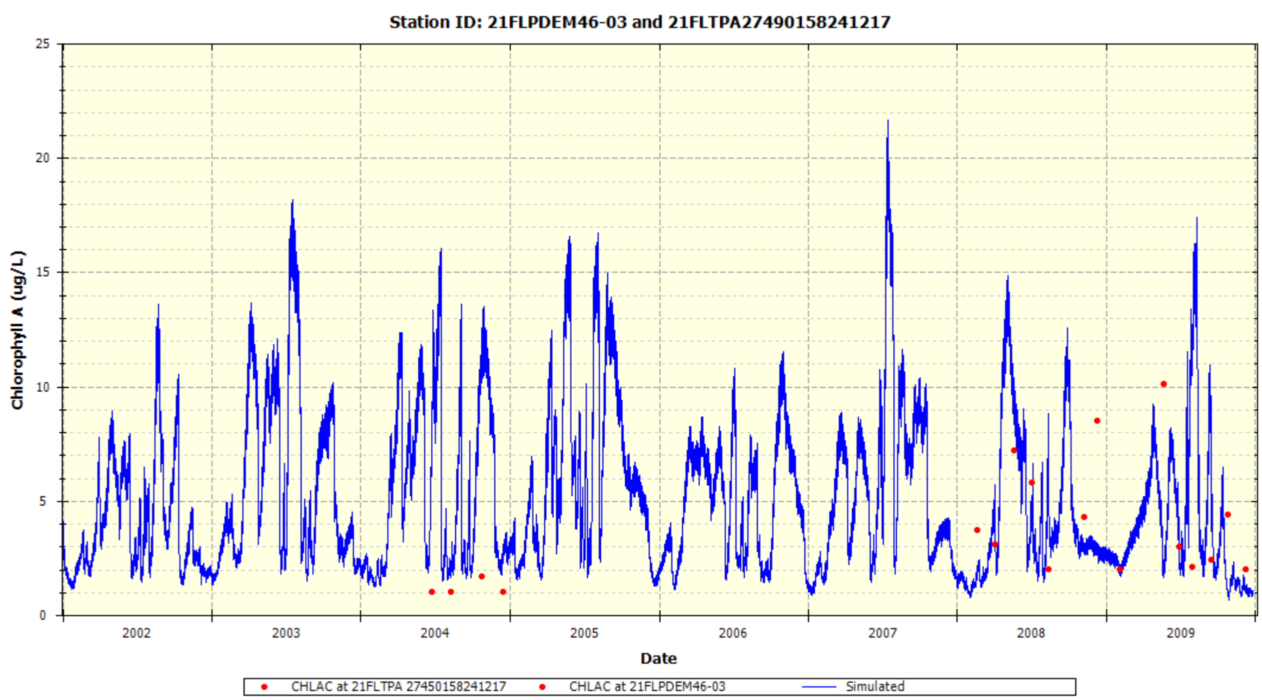

Figure 7.28 Simulated chlorophyll a (ug/L) verse measured chlorophyll a at stations 21FLPDEM46-03 and 21FLTPA27490158241217

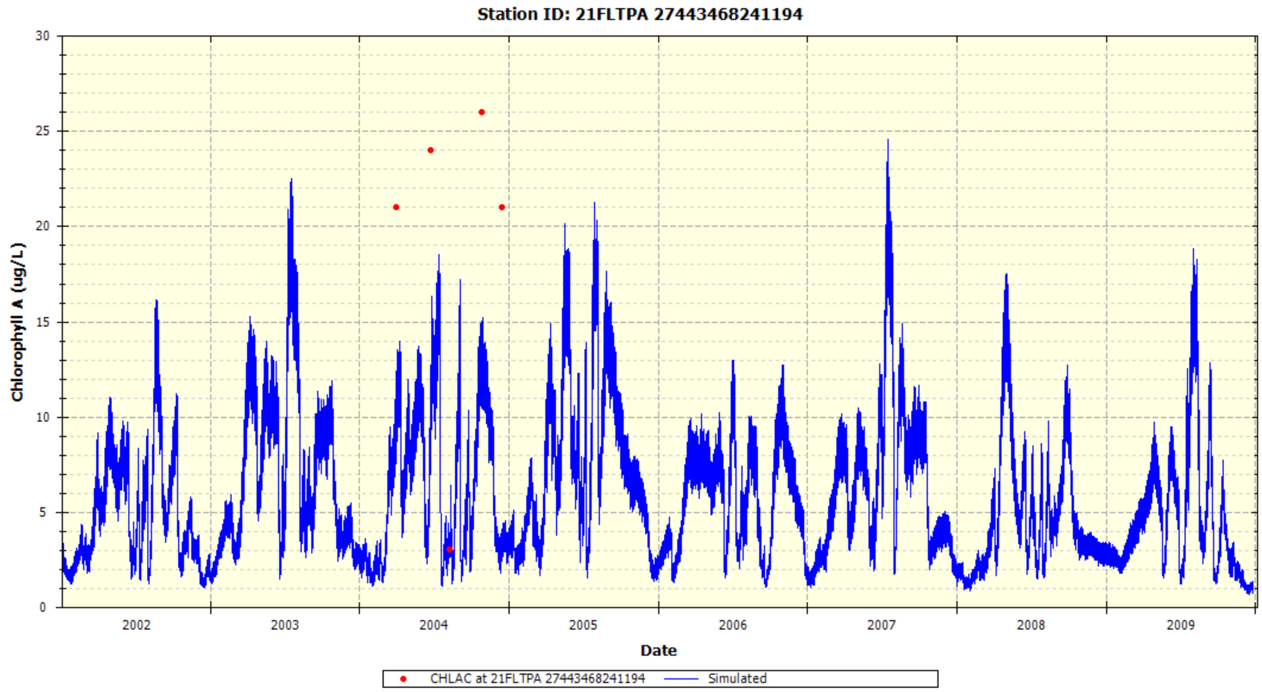

Figure 7.29 Simulated chlorophyll a (ug/L) verse measured chlorophyll a at stations 21FLTPA27443468241194

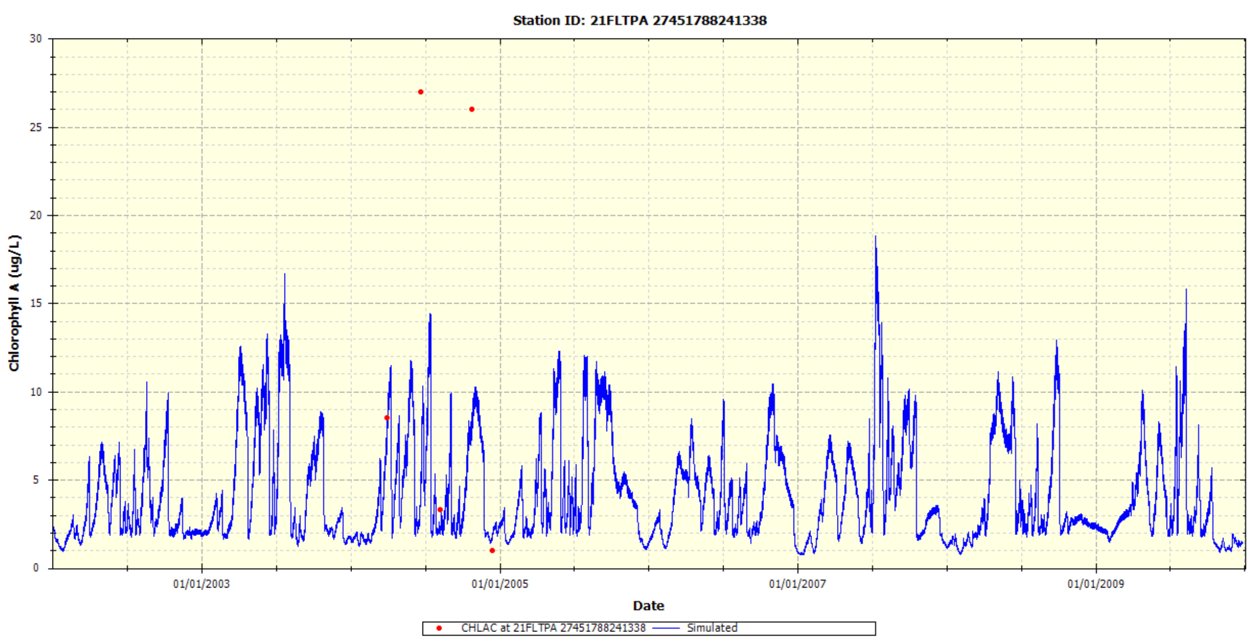

Figure 7.30 Simulated chlorophyll a (ug/L) verse measured chlorophyll a at station 21FLTPA27451788141338

7.2 Scenarios

Two modeling scenarios were developed and evaluated in this TMDL determination: a current condition and a natural condition scenario. Concentrations and loadings were evaluated to determine if DO concentrations in the natural condition scenario could meet the DO standard, and the impact of nutrients on the DO concentrations. The results from the scenarios were used to develop the TMDL.

7.2.1 Current Condition

The current condition scenario evaluated current hydrologic and water quality conditions in the watershed, specifically water quality concentration and loadings at the outlet of WBIDs 1716A, 1716B, 1716C, and 1716D. The current condition annual average concentrations for the Clam Bayou WBIDs are presented in Table 7.1. The current condition simulation was used to determine the base loadings for the WBIDs. These base loadings (Table 7.2), when compared with the TMDL scenarios, were used to determine the percent reduction in nutrient loads that will be needed to achieve water quality standards. Figures 7.12 through 7.30 provide the calibrated current condition modeled parameters for Clam Bayou.

Table 7.1 Current condition concentrations in the impaired WBIDs in the Clam Bayou basin.

Parameter	WBID 1716A	WBID 1716B	WBID 1716C	WBID 1716D
Total nitrogen (mg/L)	0.57	0.51	0.60	0.40
Total phosphorus (mg/L)	0.12	0.14	0.14	0.17
BOD (mg/L)	2.20	1.71	1.76	1.50
DO (mg/L)	5.22	5.17	5.14	5.90

Table 7.2 Current condition loadings in the impaired WBIDs in the Clam Bayou basin.

	WBID 1716A		WBID 1716B		WBID 1716C		WBID 1716D	
Parameter	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)
Total nitrogen (mg/L)	--	2,894	--	1,010	--	1,112	--	5,441
Total phosphorus (mg/L)	--	307	--	103	--	120	--	570
BOD (mg/L)	--	8,960	--	3,121	--	2,921	--	16,244

7.2.2 Natural Condition

The natural condition scenario was developed to estimate water quality conditions if there was no impact from anthropogenic sources. The point sources located in the model were removed for the natural condition analysis. Landuses that were associated with anthropogenic activities (urban, agriculture, transportation, barren lands and rangeland) were converted to upland forests or forested wetlands based on the current ration of forest and wetland landuses in the model. Additionally, following the initial natural condition scenario run, sediment oxygen demand (SOD) was revised by using the following formula: $SOD_{revised}$= (Avg $Chla_{natural}$ / Avg $Chla_{existing}$) * SOD. The lower, revised SOD represents the change expected in SOD following excessive nutrient removal from the system. The natural condition water quality predictions are presented in Table 7.3 and 7.4.

The purpose of the natural conditions scenario was to determine whether water quality standards could be achieved without abating the naturally occurring loads from the watershed. The natural condition modeling scenario indicated that the DO standard is not achievable under natural conditions, indicating that low DO is a naturally occurring phenomenon in the WBIDs 1716A, 1716B, 1716C, and 1716D. Figure 7.31 through Figure 7.35 provide the natural condition scenario modeled parameters for the Clam Bayou WBIDs. Figure 7.36 provides the cumulative distribution function of DO concentrations for both the modeled existing condition and natural condition results. The cumulative distribution curve shows there is an increase in DO concentrations in the natural condition scenario, specifically in DO concentration values less than 5 mg/L.

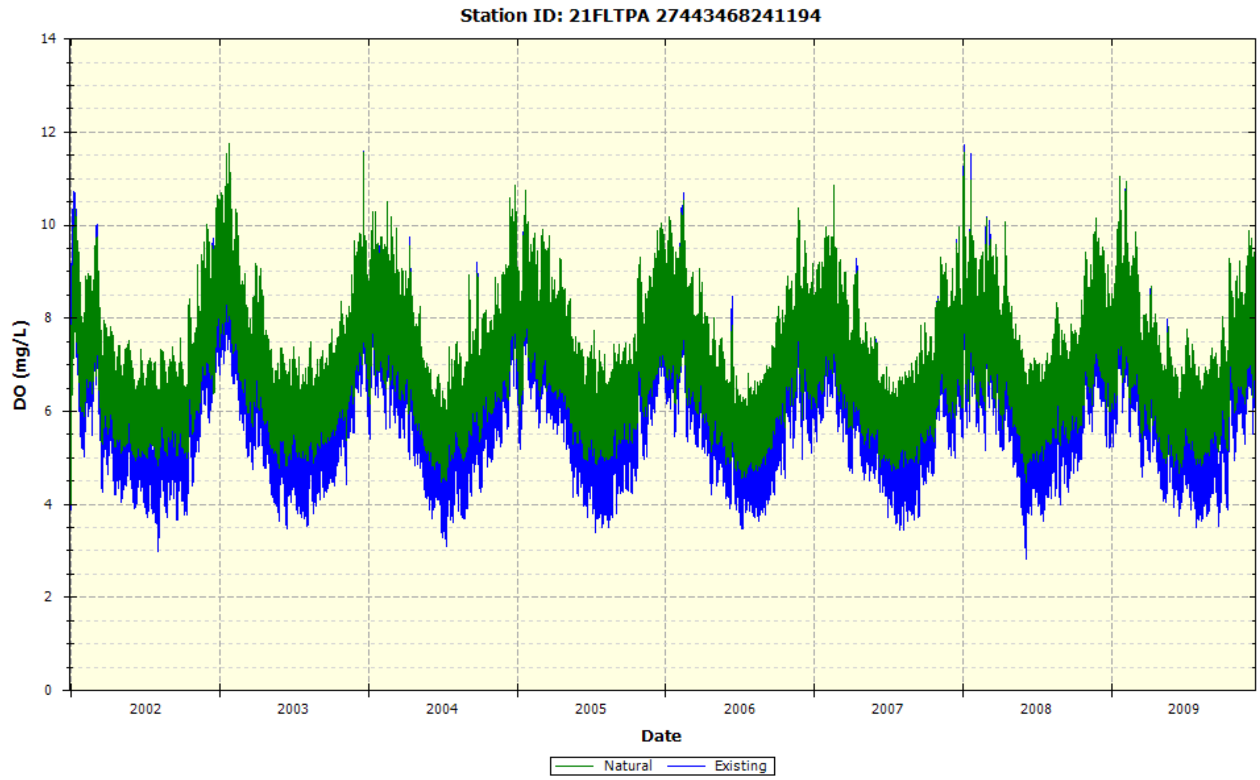

Figure 7.31 Existing condition dissolved oxygen (mg/L) and natural condition dissolved oxygen (mg/L) at the model outlet to Clam Bayou

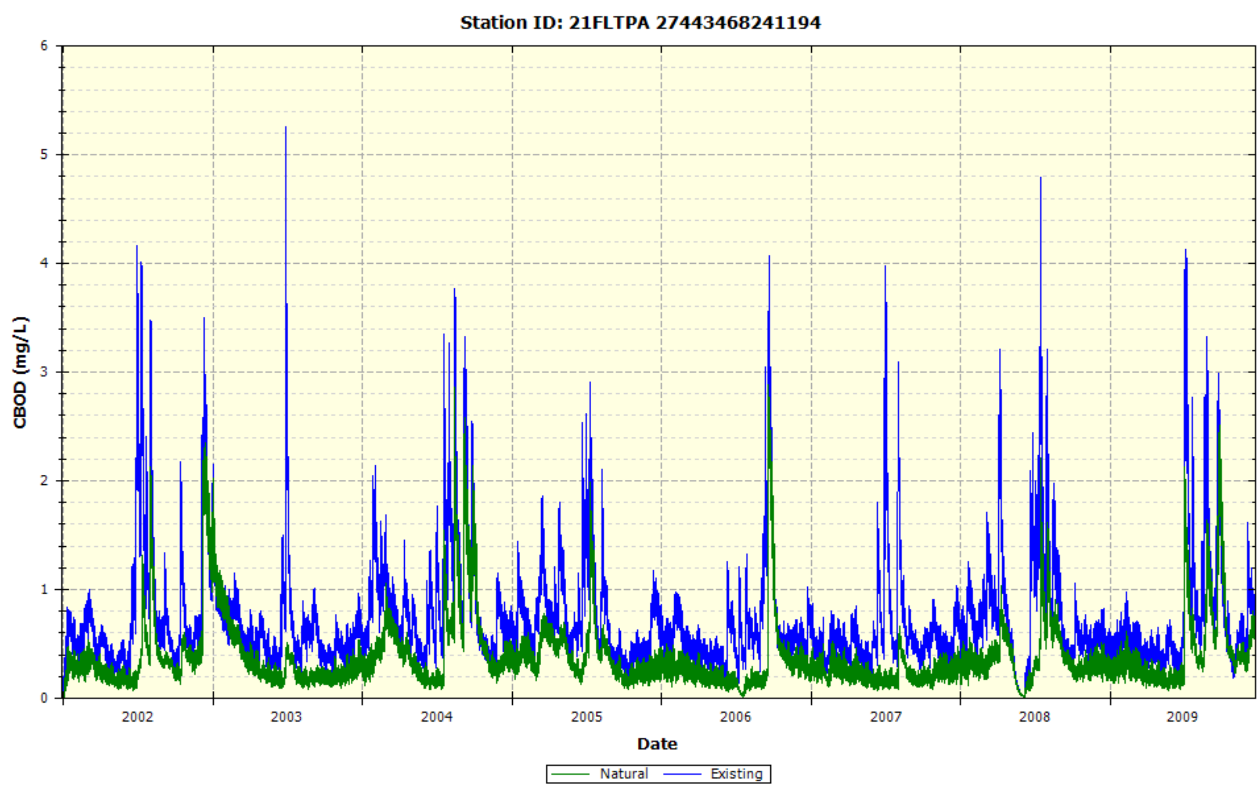

Figure 7.32 Existing condition CBOD (mg/L) and natural condition CBOD (mg/L) at the model outlet to Clam Bayou

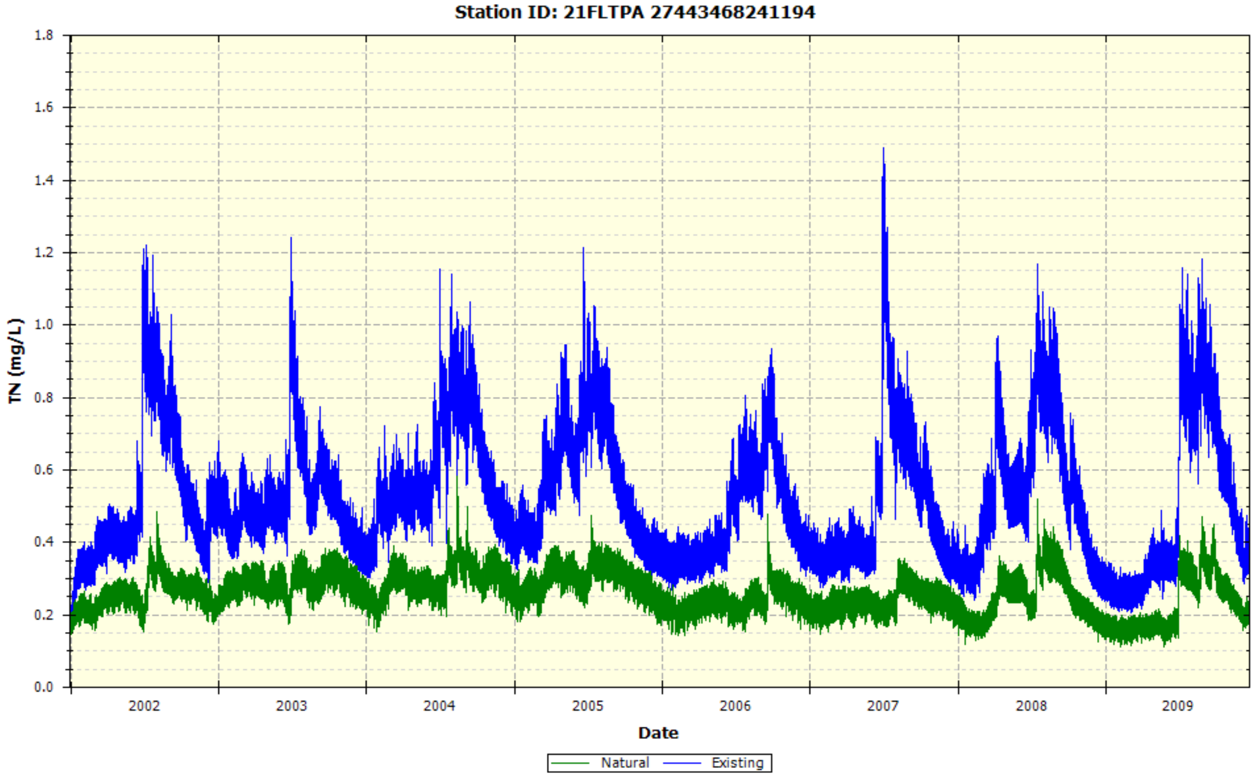

Figure 7.33 Existing condition total nitrogen (mg/L) and natural total nitrogen (mg/L) at the model outlet to Clam Bayou

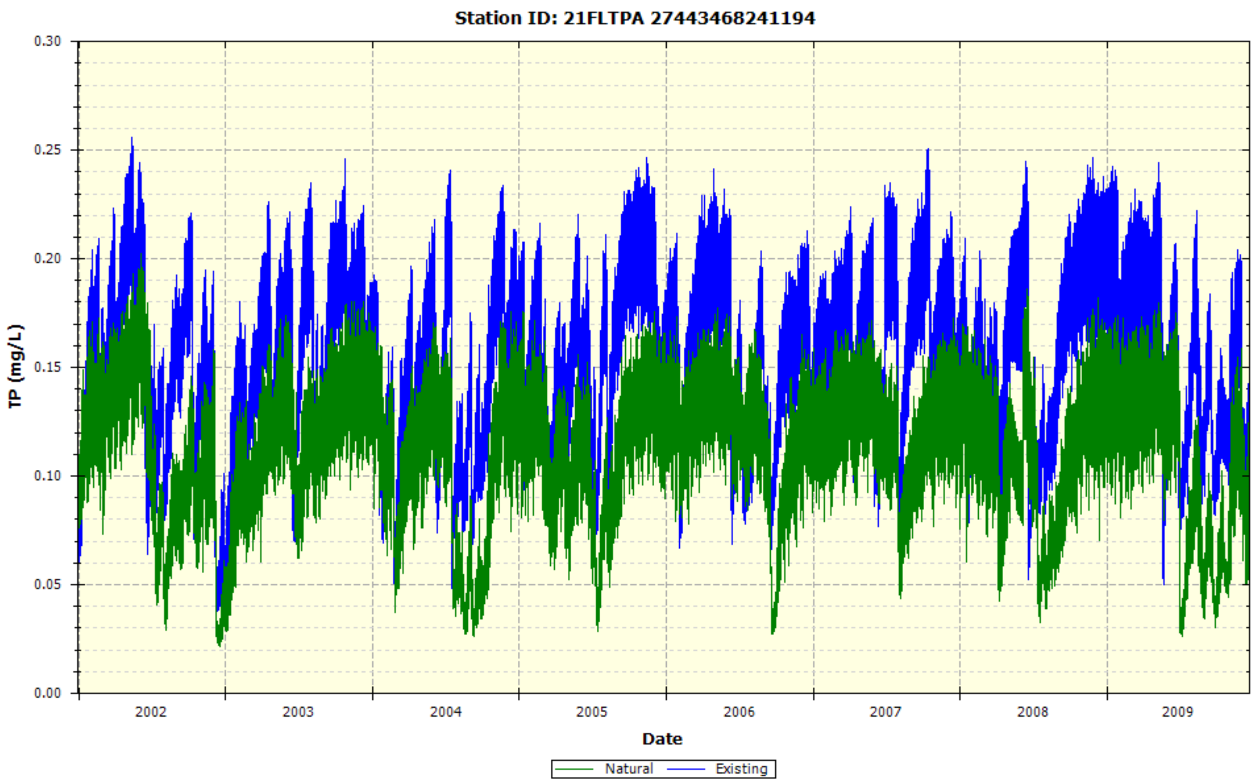

Figure 7.34 Existing condition total phosphorus (mg/L) and natural condition total phosphorus (mg/L) at the model outlet to Clam Bayou

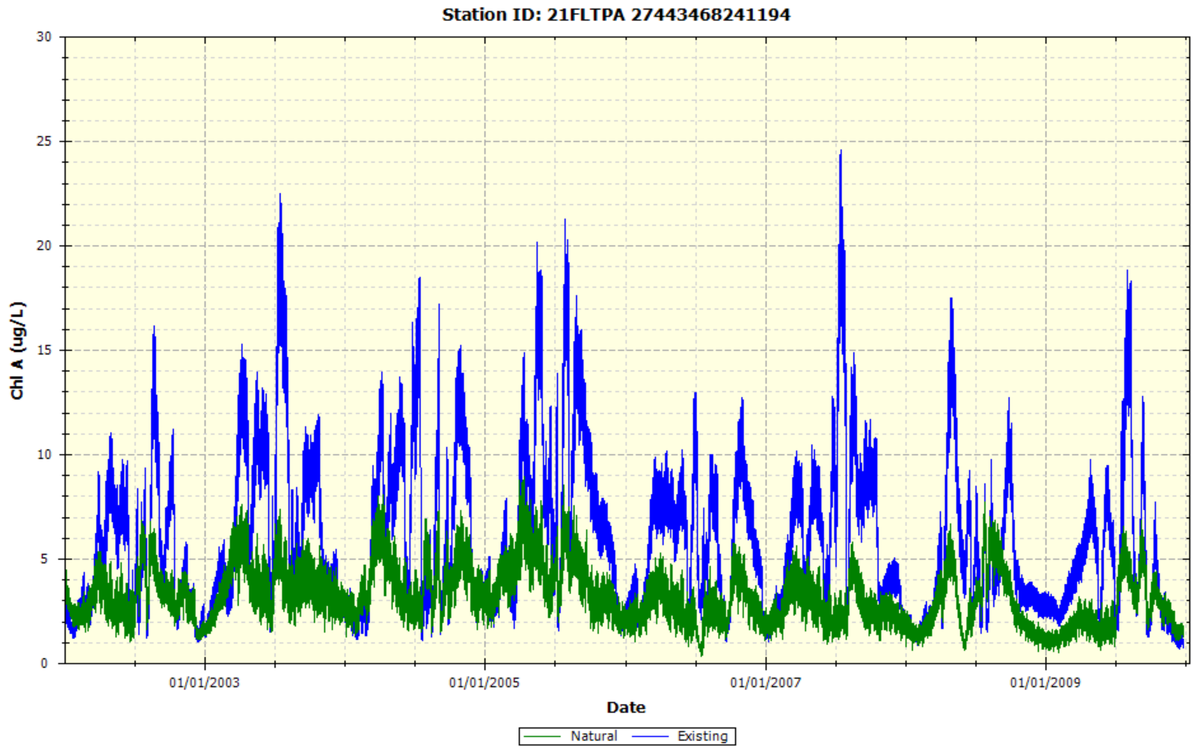

Figure 7.35 Existing condition chlorophyll a (ug/L) and natural condition chlorophyll a (ug/L) at the model outlet to Clam Bayou

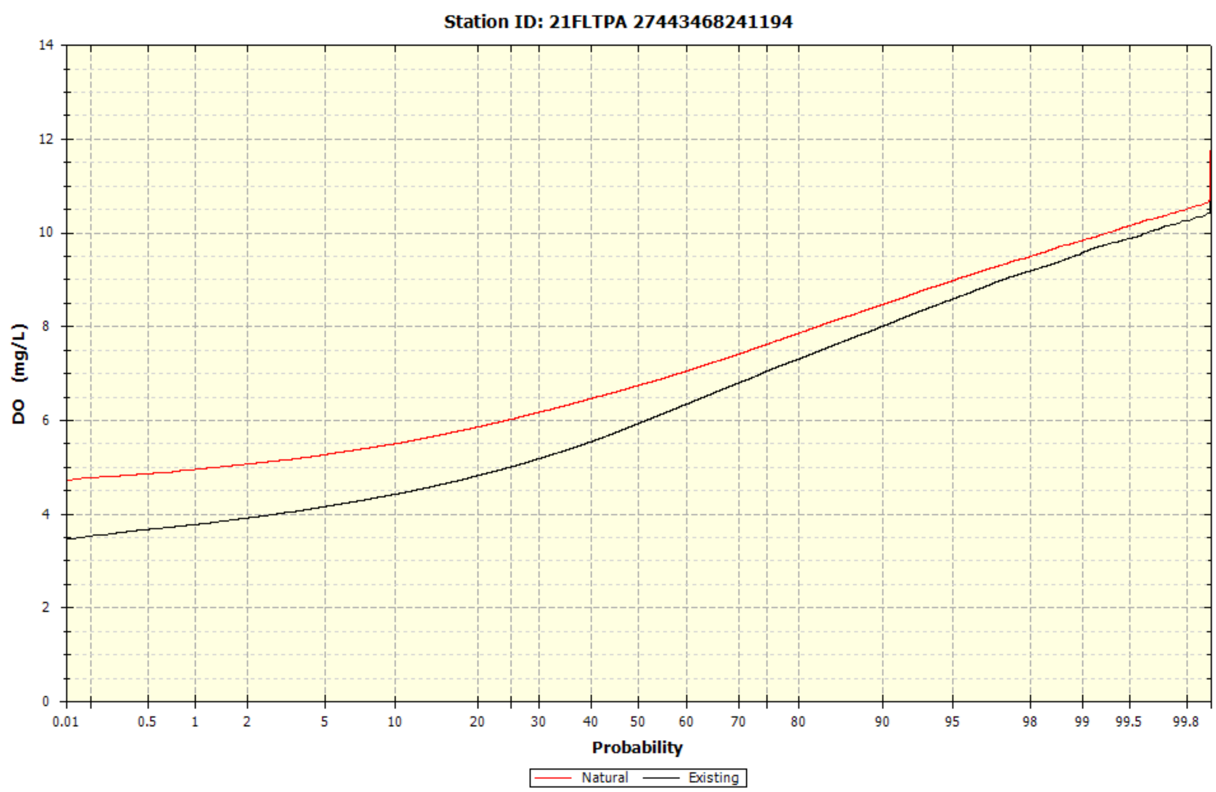

Figure 7.36 Dissolved oxygen concentration cumulative distribution function at the model outlet to Clam Bayou

Table 7.3 Natural condition concentrations in the impaired WBIDs in the Clam Bayou basin.

Parameter	WBID 1716A	WBID 1716B	WBID 1716C	WBID 1716D
Total nitrogen (mg/L)	0.30	0.32	0.36	0.34
Total phosphorus (mg/L)	0.11	0.13	0.13	0.16
BOD (mg/L)	1.05	0.94	0.95	1.27
DO (mg/L)	5.66	5.70	5.59	6.28

Table 7.4 Natural condition loadings in the impaired WBIDs in the Clam Bayou basin.

Parameter	WBID 1716A		WBID 1716B		WBID 1716C		WBID 1716D	
	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)
Total nitrogen (mg/L)	--	508	--	194	--	272	--	1,075
Total phosphorus (mg/L)	--	42	--	16	--	23	--	89
BOD (mg/L)	--	2,529	--	1,008	--	1,198	--	5,227

8.0 TMDL DETERMINATION

The TMDL for a given pollutant and waterbody is comprised of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is represented by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving waterbody and still achieve water quality standards and the waterbody's designated use. In this TMDL development, allowable concentrations from all pollutant sources that cumulatively amount to no more than the TMDL must be set and thereby provide the basis to establish water quality-based controls. These TMDLs are expressed as annual geometric mean concentrations, since the approach used to determine the TMDL targets relied on geometric means. The TMDLs targets were determined to be the conditions needed to restore and maintain a balanced aquatic system. Furthermore, it is important to consider nutrient loading over time, since nutrients can accumulate in waterbodies.

The TMDLs were determined for the concentrations coming from the upstream watersheds that directly drain into the listed WBIDs. During the development of these TMDLs, it was determined that the natural condition scenario (removal of all anthropogenic sources and landuses) did not meet the Florida standards for DO. EPA believes that setting the TMDL condition to a natural condition protects both 47(a) and 47(b) of the Florida narrative nutrient standard. It assures that no man induced activities would have caused an imbalance of flora and fauna. Natural background levels are presumed to protect aquatic life. Since Florida's water quality standards do not allow the abatement of natural conditions, this TMDL represents the lowest level of nutrients that could be established. Therefore, in order to prevent additional degradation and nutrient impairment in the downstream estuary Clam Bayou, the natural condition loadings were used to determine the TMDL. The allocations for the WBIDs for total nitrogen, total phosphorus, and biochemical oxygen demand are presented in Table 8.1 through 8.4.

Table 8.1 TMDL load allocations for Clam Bayou, WBID 1716A

Constituent	Current Condition		TMDL Condition		Percent Reduction		
	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	WLA	LA	MS4
Total Nitrogen	--	2,894	--	508	--	82%	82%
Total Phosphorus	--	307	--	42	--	86%	86%
Biochemical Oxygen Demand	--	8,960	--	2,529	--	72%	72%

Table 8.2 TMDL load allocations for Clam Bayou, WBID 1716B

Constituent	Current Condition		TMDL Condition		Percent Reduction		
	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	WLA	LA	MS4
Total Nitrogen	--	1,010	--	194	--	81%	81%
Total Phosphorus	--	103	--	16	--	85%	85%

Biochemical Oxygen Demand	--	3,121	--	1,008	--	68%	68%

Table 8.3 TMDL load allocations for Clam Bayou, WBID 1716C

Constituent	Current Condition		TMDL Condition		Percent Reduction		
	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	WLA	LA	MS4
Total Nitrogen	--	1,112	--	272	--	76%	76%
Total Phosphorus	--	120	--	23	--	81%	81%
Biochemical Oxygen Demand	--	2,921	--	1,198	--	59%	59%

Table 8.4 TMDL load allocations for Clam Bayou, WBID 1716D

Constituent	Current Condition		TMDL Condition		Percent Reduction		
	WLA (kg/yr)	LA (kg/yr)	WLA (kg/yr)	LA (kg/yr)	WLA	LA	MS4
Total Nitrogen	--	5,441	--	1,075	--	80%	80%
Total Phosphorus	--	570	--	89	--	84%	84%
Biochemical Oxygen Demand	--	16,244	--	5,227	--	68%	68%

8.1 Critical Conditions and Seasonal Variation

EPA regulations at 40 CFR 130.7(c)(1) require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The critical condition is the combination of environmental factors creating the "worst case" scenario of water quality conditions in the waterbody. By achieving the water quality standards at critical conditions, it is expected that water quality standards should be achieved during all other times. Seasonal variation must also be considered to ensure that water quality standards will be met during all seasons of the year, and that the TMDLs account for any seasonal change in flow or pollutant discharges, and any applicable water quality criteria or designated uses (such as swimming) that are expressed on a seasonal basis.

The critical condition for nonpoint source concentration and wet weather point source concentrations is typically an extended dry period followed by a rainfall runoff event. During the dry weather period, nutrients build up on the land surface, and are washed off by rainfall. The critical condition for continuous point source concentrations typically occurs during periods of low stream flow when dilution is minimized. Although loading of nonpoint source pollutants contributing to a nutrient impairment may occur during a runoff event, the expression of that nutrient impairment is more likely to occur during warmer months, and at times when the waterbody is poorly flushed.

8.2 Margin of Safety

The Margin of Safety accounts for uncertainty in the relationship between a pollutant load and the resultant condition of the waterbody. There are two methods for incorporating an MOS into TMDLs (USEPA 1991):

- Implicitly incorporate the MOS using conservative model assumptions to develop allocations

- Explicitly specify a portion of the total TMDL as the MOS and use the remainder for Allocations

This TMDL uses an implicit MOS since the TMDL targets for nutrients were set to natural background conditions.

8.3 Waste Load Allocations

Only MS4s and NPDES facilities discharging directly into lake segments (or upstream tributaries of those segments) are assigned a WLA. The WLAs, if applicable, are expressed separately for continuous discharge facilities (e.g., WWTPs) and MS4 areas, as the former discharges during all weather conditions whereas the later discharges in response to storm events.

8.3.1 Wastewater/Industrial Permitted Facilities

A TMDL wasteload allocation (WLA) is given to wastewater and industrial NPDES-permitted facilities discharging to surface waters within an impaired watershed. There is one continuous discharge NPDES-permitted point source in WBID 1716A, however no data was associated with discharger. A WLA was not calculated.

8.3.2 Municipal Separate Storm Sewer System Permits

The WLA for MS4s are expressed in terms of percent reductions equivalent to the reductions required for nonpoint sources. Given the available data, it is not possible to estimate concentrations coming exclusively from the MS4 areas. Although the aggregate concentration allocations for stormwater discharges are expressed in numeric form, i.e., percent reduction, based on the information available today, it is infeasible to calculate numeric WLAs for individual stormwater outfalls because discharges from these sources can be highly intermittent, are usually characterized by very high flows occurring over relatively short time intervals, and carry a variety of pollutants whose nature and extent varies according to geography and local land use. For example, municipal sources such as those covered by this TMDL often include numerous individual outfalls spread over large areas. Water quality impacts, in turn, also depend on a wide range of factors, including the magnitude and duration of rainfall events, the time period between events, soil conditions, fraction of land that is impervious to rainfall, other land use activities, and the ratio of stormwater discharge to receiving water flow.

This TMDL assumes for the reasons stated above that it is infeasible to calculate numeric water quality-based effluent limitations for stormwater discharges. Therefore, in the absence of information presented to the permitting authority showing otherwise, this TMDL assumes that water quality-based effluent limitations for stormwater sources of nutrients derived from this TMDL can be expressed in narrative form (e.g., as best management practices), provided that: (1) the permitting authority explains in the permit fact sheet the reasons it expects the chosen BMPs to achieve the aggregate wasteload allocation for these stormwater discharges; and (2) the state will perform ambient water quality monitoring for nutrients for the purpose of determining whether the BMPs in fact are achieving such aggregate wasteload allocation.

All Phase 1 MS4 permits issued in Florida include a re-opener clause allowing permit revisions for implementing TMDLs once they are formally adopted by rule. Florida may designate an area as a regulated Phase II MS4 in accordance with Rule 62-620.800, FAC. Florida’s Phase II MS4 Generic Permit has a “self-implementing” provision that requires MS4 permittees to update their stormwater management program as needed to meet their TMDL allocations once those TMDLs are adopted. Permitted MS4s will be responsible for reducing only the loads associated with stormwater outfalls which it owns, manages, or otherwise has responsible control. MS4s are not responsible for reducing other nonpoint source loads within its jurisdiction. All future MS4s permitted in the area are automatically prescribed a WLA equivalent to the percent reduction assigned to the LA. The MS4 service areas described in Section 6.1.2 of this report are required to meet the percent reduction prescribed in Table 8.1 through 8.4 through the implementation of BMPs.

8.4 Load Allocations

The load allocation for nonpoint sources was assigned a percent reduction in nutrient concentrations from the current concentrations coming into each of the WBIDs addressed in the TMDL report.

9.0 RECOMMENDATIONS/IMPLEMENTATION

The initial step in implementing a TMDL is to more specifically locate pollutant source(s) in the watershed. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the specified load reductions. Components of a B-MAP are:

- Allocations among stakeholders
- Listing of specific activities to achieve reductions
- Project initiation and completion timeliness
- Identification of funding opportunities
- Agreements
- Local ordinances
- Local water quality standards and permits
- Follow-up monitoring

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